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SOCIOLOGICAL SIGNIFICANCE OF LANGUAGE AND CULTURE

IT became very evident during the Second World War that England was unable to produce, at a time when their services were most urgently needed, sufficient experts in Slavonic, East European, Near Eastern, Far Eastern, and African languages to carry out essential military and political functions. Still fewer men could be found who combined a knowledge of these languages with an equal knowledge of the peoples who speak them and of their histories, social structures, and cultures. It has also become clear that, as a result of the War, British relations with these peoples will have to be based far more than hitherto on personal contacts, demanding sympathetic understanding of their ways of life and thought, and that an aloofness born of political and economic supremacy can no longer be afforded.

The realization that the study of Oriental, African, Slavonic, and East European languages, societies, and cultures is of national importance and, therefore, a concern of the State led to the appointment by Mr. Eden of an interdepartmental commission of inquiry, presided over by the Earl of Scarbrough, in December 1944. Its terms of reference were : "To examine the facilities offered by universities and other educational institutions in Great Britain for the study of Oriental, Slavonic, East European and African languages and culture, to consider what advantage is being taken of these facilities and to formulate recommendations for their improvement".

The Commission concludes from its inquiry* that the present provision for these studies is "unworthy of our country and people". Even this is an understatement. The state of linguistic and sociological research in the whole area within the Commission's terms of reference is deplorable. The facilities for teaching the required subjects in Britain were in 1939 well behind those in several European countries.

The chief reason for the public indifference which the Commission deplores is, as its report stresses, the absence of a sound academic tradition in the subjects under consideration. There have been here and there isolated professorships ; but there have lacked strong teaching departments in which a tradition could grow and be added to by one generation of scholars after another. It was not until 1916 that, to implement the findings of Lord Reay's Committee, the School of Oriental Studies was established in London, largely through the energetic backing of Lord Cromer and Lord Curzon. It took the stimulus of the First World War to bring about the establishment in 1918 of the School of Slavonic Studies, also in London. Credit for the foundation of the International African Institute in 1926, under the chairmanship of Lord Lugard, must be given to private initiative and American generosity.

The report of the Scarbrough Commission, therefore, lays it down that there can be no public enlightenment about the Far and Near East, Eastern

* Foreign Office. Report of the Interdepartmental Commission of Enquiry on Oriental, Slavonic, East European and African Studies. Pp. 192. (London : H.M. Stationery Office, 1947.) 3s. net.

Europe, and Africa until an academic tradition has been created in university departments dealing with the languages and cultures of these areas. It goes on to point out that no such tradition can be created, especially to-day when there is no longer a leisured class in Great Britain, and the Diplomatic, Consular, and Colonial Services are no longer leisurely occupations, unless students can be assured professional status and financial security. For a man without private means to take up as his life's work a study regarded by most people, including his relatives and friends, as a hobby of well-to-do eccentrics, he must have adequate funds to maintain himself during his training and research and until he has had time to publish enough of the results of his research to qualify for a teaching post. He must also have reason to believe that if he does qualify for a teaching post by the excellence of his work, there is a possibility of there being a place for him in some university department; for the genuine scholar is seldom willing to be absorbed into some other occupation for which his specialized knowledge may seem to qualify him. Neither of these pre-requisites to an academic career in the subjects under discussion have existed in the past. If the Commission's recommendations are accepted by the Government, however, they will exist in the future.

The report, which is comprehensive and admirably to the point, asks first for the strengthening of university teaching departments and the creation in certain cases of new departments in universities other than Oxford, Cambridge, and London; secondly, for a generous allotment of post-graduate studentships; and thirdly, for the establishment of research centres abroad in close liaison with British universities. These are minimum requirements involving very moderate expenditure spread over a number of years. In return for its aid, the State will receive training facilities for careers in the various countries covered by the report, and, eventually, a better informed public opinion about these areas, which are inhabited by nearly five-sevenths of the population of the world.

If the State is to receive this return, the universities must ensure, says the report with very good sense, that there is a fair balance between classical and modern studies and between linguistic and cultural studies. The tendency in the past, perhaps particularly in Semitic studies, has been to concentrate far too much on the classical literature to the neglect of the language spoken and written to-day. There has also been undue emphasis on purely linguistic teaching. A language can, of course, be learnt without the learner knowing much about the history, culture, or social life of the people who speak it; but it certainly cannot be understood without a sound knowledge of them, and there is no more fallacious guide than the man who speaks a people's language but has not studied their institutions and values. The absence of sociological research in the Near and Far East is astounding. It would not be going too far to say, for example, that no comprehensive and intensive sociological study has yet been made of any community in the Near East or India.

This lack of sociological research may be in part a shortcoming of the social anthropologists who have stuck too closely in their studies to primitive peoples, though for the good reasons that these primitive peoples are fast disappearing and the number of social anthropologists has always been very small indeed. But it is also a fault of the orientalists, whose interests have generally been too purely linguistic, sometimes too purely philological. What is required is closer co-operation between oriental studies and social anthropology, such as has existed in the African field between linguistic and anthropological studies. There are hopeful signs of this development.

It may be expected that the universities will play their part by taking a keener interest in the contemporary world. This does not mean that they will give foremost attention to practical aims in their teaching and research. It is much to be hoped that the Government will allow them an entirely free hand to give broad scholarly teaching and to conduct fundamental research in their own way. Nothing deadens teaching and inhibits research more than direction by a committee of people whose interests are in immediate practical benefits and results. If the aims of the Scarbrough Commission's report are to be achieved, it is essential that whatever committee administers the studentships the creation of which is recommended should choose the men but not the plans of research. It should not draw up a list of projects and try to find men to fit them, but should let each man, chosen on general grounds for his ability and interests, select his own field of inquiry and his own problems within that field without regard to immediate dividends.

Indeed, the Government should look on any expense it may incur in implementing this report not as charity but as a sound investment likely to pay a handsome dividend in goodwill from the peoples of the Far and Near East, Eastern Europe, and Africa, and in the commercial and political benefits which goodwill brings in its train. Nothing endears one people to another more than awareness that its history, language, and culture are a sincere and respectful concern of the other.

RADIO TRANSMISSION LINES AND WAVE GUIDES

Electrical Transmissions in Steady State

By Paul J. Selgin. (Radio Communication Series.) Pp. ix+427. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 25*s*.

The Physical Principles of Wave Guide Transmission and Antenna Systems

By Prof. W. H. Watson. (International Monographs on Radio.) Pp. xiv+208. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 20*s*. net.

THE problem associated with the applications of radio waves to communication, location or navigation is to generate high-frequency alternating currents and convey them from the source to an

antenna system which radiates the waves into space. The connecting link between the source and the radiator is termed a transmission line, and for moderately high radio frequencies may comprise a system of two parallel wires, or a coaxial cable or some elaboration of these. At the very high frequencies corresponding to wave-lengths less than a few centimetres in length, this transmission line system takes the form of hollow conductor of circular or rectangular cross-section termed a wave guide. The two books under review deal respectively with transmission lines and wave guides as used in modern radio frequency technique.

Mr. Selgin's intention in the first book is revealed by his definition of a hypothesis of steady state according to which "it is assumed that the amounts of energy transmitted through any junction over two successive equal time intervals, at any particular frequency, are not appreciably different, provided that the period of this frequency is small compared with the intervals considered". It is then pointed out that, though strictly speaking all communication signals must be regarded as transients, it is permissible to adopt this loose definition as a guiding principle for practical purposes.

Nearly half the book is devoted to transmission lines with eight of the seventeen chapters treating uniform non-reflecting lines, distortion, terminal reflexion, power flow, long lines, matching devices, composite lines and stubs and exponential lines. Having this material collected together and co-ordinated in a single volume is perhaps the most valuable feature of the book, for the treatment is thorough and competent, and this ground is not fully covered in any other single treatise. Emphasis is laid on design problems and on their mathematical solution, particularly with the aid of vector and circle diagrams. The analytical methods required are adequately introduced for a student coming fresh to the subject.

The longest chapter (No. 10, 54 pp.) is that on "Composite Lines and Stubs", which is mainly concerned with the multisection (line) transformer and its optimum design for wide-band transmission and with the selectivity and efficiency of stub tuners. Among the illustrative examples, the effect of the capacity of regularly spaced dielectric insulators in a coaxial cable is considered.

The second longest chapter (No. 14, 40 pp.) gives a full treatment of "Inductive Coupling and Transformers"; and intervalve-coupled tuned circuits are analysed in detail with advantageous use of the parabolic locus method of presenting the results.

Chapters 11 and 12 introduce electromagnetic theory in a manner well suited to the purpose of giving a deeper understanding of circuit and line theory. The clarity and conciseness of these chapters is particularly praiseworthy, as is the refreshing appeal to physical fundamentals which is rare in books intended for engineers.

An attempt is made in the last two chapters to treat valve amplifiers within the general framework of transmission through linear networks, and the gains of the grounded-cathode, grounded-grid and grounded-anode (or cathode follower) amplifiers are deduced. The treatment is rather unsatisfactory and gives the impression of attempting too much in too short a space; the unorthodox graphical symbols and the elaborate vector diagrams also tend to obscure the relatively simple nature of the analysis involved. The book is well printed and only a few errors have been noted. The bibliography is, however, disappointing, for it refers to forty books but only two original papers (both more than twenty years old), and these are not likely to be helpful as many of them are either obsolete or inaccessible to students in Great Britain. Within its scope, which intentionally excludes radiation and wave guides, the book can be recommended to the engineer who is concerned with the design of circuits and transmission lines up to moderately high frequencies, and its treatment is modern and practical without neglect of essential fundamental principles.

Prof. Watson's book is one of a new series of International Monographs on Radio, and is intended to present a description of the manner in which the technique of dealing with radio frequency transmission lines has been extended to propagation through wave guides. When the cross-sectional dimensions of a wave guide are chosen correctly in relation to the wave-length, only one characteristic mode of propagation, the so-called 'dominant wave', is effective in transmitting energy along the guide. The first five chapters of the book give a detailed theoretical treatment of the underlying physical principles of this type of radio wave propagation along wave guides. With the aid of the impedance concept the usual circuit analysis is applicable in many respects to waves along transmission lines as to waves in free space. The problem of wave propagation along a hollow rectangular guide is attacked by an investigation of a system of two interfering trains of plane waves. Chapter 3 contains a useful although brief description of the basic measuring techniques which are essential for any experimental work on wave guides, and includes reference to standing wave detectors, power and phase measurement, and the radiation pattern and gain of antenna systems. The general problem of multiple propagation of waves along guides of either circular or rectangular cross-section is dealt with in the following chapter; it is here that the two characteristic distributions in a wave guide are described. In one of these, termed *TE*, the waves are propagated in such a manner that the electric force is transverse only, while in the other case, of the *TM* waves, the magnetic force is confined to the transverse direction. By an application and extension of Babinet's principle, it is shown in the succeeding chapters how wave guides can be coupled together by means of suitable slots in their sides, and how such slots may also be used to obtain radiation from a wave guide into free space. This portion of the book presents the results of much of the author's original work in recent years in the study and development of slot radiators and antenna systems for centimetre wave transmission and reception. Chapters 8 and 9 discuss in some detail the principles and characteristics of various types of wave-guide arrays and slot aerials, many forms of which have been developed for special applications of radar technique.

In this book, which is well produced and illustrated, Prof. Watson has presented very clearly the results of much original work in elucidating the physical principles of wave guide transmission, the technique of which is likely to play an important part in the applications of very short radio waves in the future. Much of the work in the book is made generally available for the first time, and most of the references given at the end of the book are to papers and reports which have hitherto been classified as confidential. With the rapid publication now taking place in

scientific and technical journals in Great Britain and in America, the author should be able to improve this bibliography in a later edition: the opportunity might then also be taken of adding a subject index to the name index which is given at the end of the present book, although the detailed nature of the contents virtually forms a subject index.

R. L. SMITH-ROSE

MODERN CARBOHYDRATE CHEMISTRY

Advances in Carbohydrate Chemistry

Edited by W. W. Pigman and M. L. Wolfrom (Associate Editor for the British Isles: Stanley Peat.) Vol. 2. Pp. xiv+323. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1946.) 6.60 dollars.

THIS volume by no means suffers in comparison with the first in this series (see *Nature* **157**, 676; 1946), and represents a valuable collection of articles setting out the state of knowledge of the subjects selected up to about the end of 1945, the number of references dated 1946 amounting only to six. The choice of subjects is suitably wide, and the articles on anhydro sugars, the analogues of ascorbic acid, the chemistry of mucopolysaccharides and mucoproteins, bacterial polysaccharides and the chemistry of pectic materials are outstandingly good.

In common with the reviewer of Volume 1, I think it is unfortunate that in a publication of this kind detailed experimental work should be included, for great difficulties are likely to arise, especially for abstractors, if the practice is extended. Although none of the British authors is an offender in this respect, the fact that a member of the editorial board has included experimental details in both volumes gives rise to misgivings for the future.

The first thirty-six pages are devoted to an exhaustive memoir by C. S. Hudson on melezitose and turanose. The history of the chemical investigations is described in great detail, and the evidence proving that turanose is 3-α-*d*-glucopyranosyl-*d*-fructose is presented. That experimental evidence is lacking as to whether melezitose contains a sucrose residue is made clear, although many workers will be surprised if this is not the case. The present description of melezitose must, therefore, be 3-[α-*d*-glucopyranosyl]-(?)-*d*-fructofuranosyl-α-*d*-glucopyranoside.

The account by Stanley Peat of the chemistry of the anhydro sugars is noteworthy, and represents a complete survey of this important and fascinating topic. Not only is this article invaluable for reference purposes, but high praise is due for the logical treatment and clarity of style in discussing a complex subject which the author himself has done much to develop.

In the section on ascorbic acid analogues, Fred Smith summarizes the methods of synthesis and properties of these substances, and the hitherto puzzling behaviour of the saccharodilactones is explained by their conversion to reducing enolic forms.

The account by R. Lespieau of the synthesis of hexitols and pentitols from unsaturated polyhydric alcohols is decidedly stimulating to those carbohydrate chemists who, like the reviewer, tend to neglect the possibilities of synthesis on account of the vast field of natural products awaiting investigation.

Harry J. Deuel, Jun., and Margaret G. Moorhouse discuss the interrelation of carbohydrate and fat metabolism in an article covering forty-one pages in which nearly two hundred and fifty references are quoted. This article fulfils one of the objects set forth in the Editors' preface to Volume 1, namely, "It may be found desirable to present several reviews of controversial subjects, particularly in those fields undergoing a rapid state of development".

The extraordinary complexities of the mucopolysaccharides and mucoproteins are discussed by Maurice Stacey in a stimulating contribution which should do much to encourage workers to embark upon researches on these substances. The unusual step of introducing exclamation marks into a scientific article presumably indicates the author's impatience with earlier work in this field; it must be remembered, however, that we stand upon the shoulders of the previous generation even if the foothold seems precarious at times.

Taylor H. Evans and the late Harold Hibbert are responsible for an excellent report on bacterial polysaccharides. I was working with Hibbert in Montreal when some of the investigations described were in progress, and it is a great pleasure to see the results collected together, and to recall the enthusiasm of one whose scientific achievements were not, perhaps, sufficiently appreciated in his life-time.

E. L. Hirst and J. K. N. Jones contribute an account of the chemistry of pectic materials which might well serve as a model for future articles, for the temptation to expand by the full discussion of outmoded earlier results is rejected, to the great profit of the reader.

The polyfructosans and difructose anhydrides are described by Emma J. McDonald in a useful survey of a subject the study of which is beset by many experimental difficulties, and a short survey of cellulose ethers of industrial importance by Joseph F. Haskins reminds the reader of the advances made in a more strictly utilitarian field.

Few mistakes were found in this attractive and useful book, and these principally in the initials of the authors in the references. The practice of printing the Christian name in full for women authors, which indeed is highly commendable, has resulted in an apparent sex reversal (references 30, 65, 103, in the article on bacterial polysaccharides), as those will observe who studied public health chemistry under Dr. E. Ashley Cooper at Birmingham.

E. G. V. PERCIVAL

X-RAY ANALYSIS AS A TOOL IN CHEMISTRY AND TECHNOLOGY

Röntgenographisch-analytische Chemie

Möglichkeiten und Ergebnisse von Untersuchungen mit Röntgeninterferenzen in der Chemie. Von Prof. Dr. E. Brandenberger. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, 7.) Pp. 287. (Basel: Verlag Birkhäuser, 1945.) 28.50 Swiss francs.

IN Great Britain, X-ray crystallographers are abundant, and each can afford to specialize. Some of us take to hydrocarbons, others only to carbohydrates, and to others again only the fibrous state

of matter appeals. In Switzerland, crystallographers are scarce, and a man who wants to serve university and industrial laboratories alike must be able to master not only all the techniques of X-ray analysis, but also electron diffraction and radiography as well. Prof. E. Brandenberger at Zurich directs such an all-round X-ray laboratory, and in the book under notice he tries to explain to his colleagues the potentialities and limitations of X-ray diffraction.

The title suggests a narrower field than is actually covered, for the book ranges beyond the applications of X-ray analysis to chemistry. As the author explains in the introduction, he does not aim at adding one more to the many text-books on the principles and methods of X-ray analysis—personally I have never found that there was such an abundance—but to review the variety of problems that can be investigated and to illustrate the kind of information that X-ray analysis can provide in each particular case. For all explanations of fundamental principles the author refers to other literature (not even Bragg's law is derived), and only a brief section at the end of the book is devoted to actual crystal structure analysis, including an exposition of some of the more elementary laws of crystal chemistry.

The first part of the book deals with the identification of crystalline phases; this involves the author in the difficulties of defining the term 'crystalline' and leads him to an elaborate classification of lattice types intermediate between the crystalline and the amorphous state. The other sections deal with the analysis of mixtures and multiphase systems, with the study of crystal texture and with reactions in solids. In each chapter the uses of X-ray analysis are rigorously classified and sub-classified, detailed instructions about the preparations of specimens are given, and lists are drawn up of all the different phenomena that might occur and of their interpretation. Some readers may find the absence of any connecting links between the observations and the conclusions to be drawn from them a little disconcerting. It has to be accepted as a statement of fact, say, that lattice distortion causes asterism on Laue pictures or that line-width is an inverse function of crystal size, and no explanation, even qualitative, is offered to the curious about the mechanism involved. Incidentally, workers in Great Britain will probably consider the author to be over-optimistic when he asserts that both the average size of the crystallites and the degree of lattice distortion can be determined from one powder photograph by plotting successively $b \cos\theta$ and $b \tan\theta$ against θ.

There are long lists of references at the end of each chapter; some of those referring to German papers which appeared during the War may be new to readers in Britain. Unfortunately, no author index is provided.

To the university student and to the reader who seeks to understand physical phenomena the book has little to offer; but workers wishing to apply more powerful techniques to the examination of materials and processes might find parts of it useful and interesting, though not very easy to read. Personally, I am inclined to think that the potentialities of X-ray analysis can be judged more easily from a knowledge and understanding of the fundamental physical principles than from a survey of its applications, however painstakingly compiled.

M. F. Perutz

LIVESTOCK IMPROVEMENT IN U.S.S.R.

Stockbreeding and the Artificial Insemination of Livestock

By V. K. Milovanov and I. I. Sokolovskaya. Translated by Dr. A. G. Morton. Pp. 160. (London: Hutchinson's Scientific and Technical Publications, 1947.) 25*s*. net.

THIS book presents the Russian point of view on the scientific and practical methods which can be used for the improvement of livestock. Mention of some of their principal local breeds and a tribute to early English breeders is contained in the introduction. Darwin's theories on the causes for variation and on natural selection form the main theme throughout the first two chapters. Correlated variations are illustrated by examples from Russian experimental work which shows the relative proportions of different parts and tissues of the body in different types of sheep (milk, meat and wool) and of cattle (meat, milk and draught). The importance of the creation of suitable environmental conditions in which to make selection of breeding animals is stressed. Many ideas novel to the British breeder are propounded, for example, that nervous activity is associated with body conformation. Pavlov's finding that the 'over fine' animal has weakness in both stimulatory and inhibitory processes is quoted in support of this.

In a chapter on selective breeding 'compensatory matings', that is, mating an animal which has a certain defect with another which is particularly good in this respect, are criticized, while a system of 'homogeneous matings' (like to like) is approved. Breeding methods, such as inbreeding, line-breeding and economic cross-breeding, are discussed, often with reference to English examples.

Perhaps the most interesting chapter in the book is that on the artificial insemination of livestock; the Russian method of insemination by semen-filled paper capsules is described and illustrated. Many of the statements made in this chapter could, with advantage, be backed by full experimental details to support them, since in some respects at any rate they differ from the views usually accepted. For example, it is stated that superabundance as well as insufficiency of spermatozoa has an adverse effect on fertilization. Details are given, however, of selective fertilization of rabbit ova by the inseminated sperm of two different varieties. Methods for testing the quality of the semen are described; but no mention is made of recent methods of insemination developed in the United States and in Great Britain.

A chapter on the maintenance, feeding and utilization of breeding animals contains much useful information on the effects of different feeding-stuffs on semen production, on methods of testing male and female animals for fertility, and on the conditioned reflexes associated with service. The lack of understanding of these latter is a frequent cause of bulls failing to function properly at artificial insemination centres.

In the concluding chapters the development of the young animal is outlined with special reference to the effect of nurture on its development, while observations are also included on the formation of new breeds and the improvement of old ones.

British breeders will find in the book a number of the old, but perhaps now not too widely read, ideas

of Darwin on the selection and evolution of animals under domestication, interspersed with many new points of view and observations on reproduction and livestock breeding. JOHN HAMMOND

AN INTRODUCTION TO MODERN PHYSICS

From Galileo to the Nuclear Age

An Introduction to Physics. By Prof. Harvey Brace Lemon. Revised edition of "From Galileo to Cosmic Rays". Pp. xviii+451. (Chicago: University of Chicago Press; London: Cambridge University Press, 1946.) 21*s*. net.

ANY book that aims at presenting a readable account of modern science is to be welcomed, and Dr. Lemon's work on the development of physics from Galileo to the present time has this objective specially in view. Such a study, he claims, should have "something of that human interest that attaches to great personalities, but most of all it should try to show explicitly and implicitly how a great scientific field of thought has come into being. Moreover it should indicate the satisfaction enjoyed by those who participate in such a development of thought, as well as its practical advantages to mankind." Even a cursory glance at this volume shows how far the author has departed from conventional academic form, in order to interest his readers. His colloquial and homely style, together with many well-produced illustrations (sometimes stereophotographs) of a topical and frequently unconventional type, are designed to meet the needs of first-year university students in other faculties who have little background knowledge of the physical sciences. Though based on the curriculum of the University of Chicago, Prof. Lemon's treatment will undoubtedly appeal to similar students elsewhere, and, indeed, to the general reader.

The book is divided into five parts, dealing respectively with mechanics, heat, electricity and magnetism, electricity and matter, waves and radiation. Attention is directed to the underlying importance of the work of Galileo and Newton, and the first part includes successive chapters on work, energy, conservation of energy, power, and concludes with a convincing treatment of the problems of atmosphere and hydrosphere. Prof. Lemon has added to the general interest of his subject by including references to the origin of the Fahrenheit scale, the measurement of temperature by electrical means, and so on: the section on heat ends with a chapter on kinetic theory. Part 3, "Electricity and Magnetism", contains the ground-work study necessary for the appreciation of modern developments. In particular, a helpful approach to 'lines of force' is made by consideration of a gravitational field. In the last two parts of the book, the reader is introduced to an interesting survey of the conduction of electricity through gases, photo-electric and thermionic effects, electrons, radioactivity, electromagnetic waves, and atomic structure. In the part especially dealing with waves, a chapter on sound is inserted.

Though "From Galileo to the Nuclear Age" is primarily a survey of the modern achievements of physics and their dependence on the work of pioneers, the author does not ignore the implications and possibilities of science at this time. "Will man be able in the future so to conduct his political, social, and economic life as to put an end to war and prevent for the future the much greater powers of destruction that soon *all nations* will possess? *Unless this can be accomplished the darkest of all ages surely lies ahead; the rare joy that in the past has gone with the acquisition of knowledge will be known no more.* . . . Let us devoutly hope that in some way these problems may be met in time so that future generations again can get some joy from probing still more deeply into the heart of Nature." H. D. ANTHONY

DISSECTION OF THE CAT

Functional Anatomy of the Mammal

A Guide to the Dissection of the Cat and an Introduction to the Structural and Functional Relationship between the Cat and Man. By Asst. Prof. W. James Leach. (McGraw-Hill Publications in the Zoological Sciences.) Pp. viii+231. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 12*s*. 6*d*.

THE choice of a mammalian type suitable for dissection as an introduction to human anatomy and physiology has usually fallen on the rabbit or the rat. The rodent, however, is in many ways less suitable than the carnivore, which is less primitive and is structurally a little nearer to man. We welcome, therefore, this book on the cat as an elementary account of a common and easily obtained mammal.

Constant comparisons with human anatomy and physiology are stressed throughout, and there are many useful summaries. The effects of posture on modifications of structure, especially as regards the upright habit in man, are referred to in an interesting way that makes the book read well, and relieves it from the tedium of names and descriptions so characteristic of the average text-book. At the end of many of the chapters, problems relating to physiology, mechanics of joints and muscles, and surgery are suggested as a stimulus to the future nurse or medical man.

The systems of the body are dealt with in turn, using the injected cat for dissection. Has the author, however, used the just-born kitten instead of the adult cat? For many of the organs it proves much easier, although so much smaller. This is particularly the case with regard to the sympathetic nervous system, which can be demonstrated with ease owing to the relatively large size of the ganglia and the gelatinous nature of the connective tissue. The difference between the fœtal and adult circulations can also be elucidated.

The original line block illustrations are excellent, especially those relating to the skeleton and muscles. The labelling in full is also good. But the half-tone reproductions of drawings by John Trainor do not mix well with the others, and illustrations from other authors have not always been correlated with the text, so that the junior student for whom the book is intended will sometimes find it difficult to recognize the parts under their Latin names. The author's Latin is irregular; foramen ovale changes in the course of the book to foramen ovalis, while fossa ovalis becomes fossa ovale; the plural of plexus is wrongly given as plexi. These are small points that could be corrected in a later edition.

As with all McGraw-Hill publications the book is well produced and the price is reasonable.

N. B. EALES

RESEARCH IN GERMANY ON THE TECHNICAL APPLICATION OF ATOMIC ENERGY*

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EVEN ten years ago, physicists were well aware that the utilization of atomic energy could not be realized without a fundamental extension of scientific knowledge. In spite of the remarkable progress in experimental nuclear physics which followed the introduction of high-voltage equipment and the invention of the cyclotron, no physical phenomenon was known, even as late as 1937, which offered the remotest possibility of exploiting the enormous quantities of energy lying latent in atomic nuclei.

It was the discovery of the fission of uranium by Hahn and Strassmann[1] in December 1938—in other words, the fact that the uranium nucleus can be split into two fragments of comparable mass when bombarded by neutrons—which brought the actual utilization of atomic energy within reach. Following this discovery, Joliot and his co-workers[2] succeeded in proving, in the spring of 1939, that in the act of fission the uranium nucleus itself emits several neutrons, thus making a chain reaction fundamentally possible. Thereafter the possibility of nuclear chain reactions was eagerly debated among physicists, particularly in the United States; in Germany it was discussed by Flügge[3] in *Die Naturwissenschaften* in the summer of 1939. Meitner and Frisch[4] had already directed attention to the enormous quantities of energy set free in the fission process.

Public interest in the problems of atomic physics was negligibly small in Germany between the years 1933 and 1939, in comparison with that shown in other countries, notably the United States, Britain and France. Thus, while in America, previous to 1939, a whole series of modern research laboratories equipped with high-voltage plants and cyclotrons was springing up, in Germany there were only two adequately equipped laboratories; and these were not supported by the State, but sponsored by a private body, the Kaiser Wilhelm Gesellschaft. These two institutes were the Kaiser Wilhelm Institutes at Heidelberg and Berlin-Dahlem; each possessed a small high-voltage set suitable for nuclear research. A cyclotron for such work was altogether lacking—the Heidelberg cyclotron, again built entirely by private funds, and mainly designed for medical investigations, was started as late as 1938, and could not be tested out before 1944. Only with the outbreak of war did the awakened interest of the authorities allow of more extended facilities for nuclear research.

The following report deals with those particular investigations which had for their purpose the technical utilization of atomic energy. The many purely scientific problems which arose in more or less close connexion with the technical problem will not be discussed here; they will be dealt with in a forthcoming FIAT* Review by Flügge and Bothe. I may, however, mention the extensive chemical investigations of Hahn and his co-workers on the fission products of uranium, carried out throughout the War in the Kaiser Wilhelm Institute for Chemistry, the great majority of which have been published.

Almost simultaneously with the outbreak of war, news reached Germany that funds were being allocated by the American military authorities for research on atomic energy†. In view of the possibility that England and the United States might undertake the development of atomic weapons, the Heereswaffenamt created a special research group, under Schumann, whose task it was to examine the possibilities of the technical exploitation of atomic energy. As early as September 1939 a number of nuclear physicists and experts in related fields were assigned to this problem, under the administrative responsibility of Diebner. I should mention the names of Bothe, Clusius, Döpel, Geiger, Hahn, Harteck, Joos and v. Weizsäcker among those so employed. At Schumann's behest, the Kaiser Wilhelm Institut für Physik in Berlin-Dahlem was nominated as the scientific centre of the new research project. The Institute came accordingly under the administration of the Heereswaffenamt; a step which disregarded the rights of the Kaiser Wilhelm Gesellschaft, and so led to the departure of its director, Debye, who as a Dutch citizen could not continue to serve under the ægis of a German war department.

As a result of the first conferences in the autumn of 1939, it was clear that there were two lines of attack possible in the exploitation of nuclear energy. One could attempt the separation of the rare isotope U(235) from ordinary uranium. This isotope, following theoretical arguments due to Bohr, must be immediately applicable either to the controlled production of energy, using primarily the slow-neutron reaction, or directly as an explosive in bombs, using the fast-neutron reaction; the separation of U(235) was, however, a problem which made the greatest possible demands on engineering technique. Secondly, one could mix ordinary uranium with a substance which would slow down the neutrons produced in the nuclear fission without absorbing them. These slow neutrons give rise preferentially to the fission of U(235) and thus maintain the chain reaction. A rapid deceleration of the neutrons is required, in order that the region of resonance absorption by U(238) should be rapidly traversed; for if absorbed they are lost to the chain

* This article is a slightly abridged translation of a paper appearing in *Die Naturwissenschaften*.

* FIAT Reviews of German Science, 1939–1946: a series of authoritative accounts of the progress made in both natural and applied science in Germany during the War. These reviews have been sponsored jointly by British, American and French FIAT (Field Intelligence Agency (Technical)), and a limited edition is expected to be ready for distribution before the end of 1947.

† Cf. Smyth Report, p. 27: Initial approaches to the Government. In actual fact, U.S. Government funds were first used at the turn of the year 1939–40 (p. 28), whereas the first discussions between men of science and the American navy took place as early as March 1939.

reaction. The advantage of this arrangement is that the chain reaction can be controlled through the heat developed thereby, so that energy can be abstracted in amounts sufficient for technical applications.

Thus two lines of purely scientific investigation were marked out: first, to develop refined methods for the separation of isotopes; secondly, by measurement of the effective cross-sections of a range of possible substances, to determine whether the alternative line of attack was at all practicable. Harteck pointed out, as early as the autumn of 1939, that it might be advantageous, in regard to the second scheme, to have the so-called moderator physically segregated from the uranium. This suggestion gave rise to theoretical investigations as to whether, with the effective cross-sections of such moderator substances as were known at the time, an arrangement having a homogeneous mixture of uranium and moderator, or one with a local separation (for example, in layers), led to the more favourable production of energy. A tentative theoretical investigation made by Heisenberg, in December 1939, led to the result that while ordinary water was unsuitable as a moderator, it should be possible with heavy water (D_2O) or very pure carbon to produce energy in positive amount, provided the moderator and uranium were arranged in layers. This arrangement, however, demanded the highest degree of purity of the substances involved. At the same time, it was evident that a certain minimum size of apparatus was necessary for the production of energy. Nevertheless, with a small set it is still possible to determine whether there would be a production of energy if the apparatus were suitably enlarged. Thus if we feed such a small plant with neutrons from an internal source, more neutrons must escape from the surface than are supplied by the source, if the layer arrangement is favourable to energy production; if unfavourable, then fewer neutrons escape than are supplied by the source. These small model plants, which are continuously fed from a neutron source, are called 'neutron-injected piles'. The ratio k of the number of neutrons escaping from the pile to that fed in by the source can be used to characterize the pile. If $k \ll 1$, the arrangement is unsuitable for the production of energy; if $k > 1$, energy will be produced on enlarging the pile.

In 1940, measurements of the most important effective cross-sections were carried out, especially by Bothe and his collaborators, and by Döpel and Heisenberg. At the same time, investigations on the masses and energies of the fission products were being pursued by Jentschke and Prankl[5] and by Flammersfeld, P. Jensen and Gentner[6], and on the spectrum of the neutrons produced by Kirchner and v. Droste and by Bothe and Gentner[7]. The theory of neutron absorption in the U(238) resonance line was laid down by Flügge and Heisenberg. On the technical side the following results were the most important: the absorption cross-section of heavy water proved to be so low that this substance was certainly usable in the construction of a uranium pile (Döpel and Heisenberg). The work of v. Droste on large quantities of sodium uranate, and of Harteck and the Hamburg group—Groth, H. Jensen, Knauer and Süss—on U_3O_8 in solid carbon dioxide, furnished the first criteria for the distribution of neutron density in certain arrangements of uranium and moderator. In the autumn of 1940, the first pile, constructed of layers of U_3O_8 and light paraffin, was built at Berlin-Dahlem and its characteristics measured (Wirtz, Fischer, Bopp). This model pile gave, as expected, $k < 1$, that is, the arrangement was not suitable for the production of energy. Nevertheless, it yielded valuable data for further piles using alternate layers of U_3O_8 and heavy water.

In the summer of 1940, v. Weizsäcker pointed out that a uranium pile, besides generating the fission products of uranium, will constantly produce the uranium isotope U(239) and its transformation series; and that theoretically these transformation products should show the same properties as U(235) in regard to neutron fission. It remained thereby an open question whether β-decay ended at element No. 93 or 94 or even later; for, since no cyclotron was available in Germany, these elements could not be prepared in sufficient quantity for the examination either of their nuclear properties or chemical characteristics. Nevertheless, it appeared likely, from v. Weizsäcker's work, that an energy-producing pile might be used for the production of an atomic explosive, even though the practical details involved remained uncertain. In fact, this method had been employed on the grand scale in America. The American piles deliver as a transformation product of U(239) the element plutonium $^{239}_{94}Pu$, which is used in the manufacture of atomic bombs.

Important technical problems immediately arose out of these scientific investigations. The production of U_3O_8 of the highest purity was assigned to the Auer-Gesellschaft by the Heereswaffenamt. The casting of the corresponding metal powder was afterwards allotted to Degussa in Frankfurt. The production of heavy water, which was obviously of the greatest importance for the construction of a uranium pile, was planned at the Norsk Hydro factory at Rjukan in Norway. Harteck, in conjunction with Süss, H. Jensen and Wirtz, developed a number of projects which resulted in an increase of heavy water production at Rjukan far beyond the former output of 10–20 litres a month. Moreover, Harteck and Clusius put forward detailed plans for the production of heavy water in Germany. The improvements in the Norsk Hydro factory finally increased production in the summer of 1942 to about 200 litres per month. Further, steps were taken by order of the Heereswaffenamt for the production of very pure carbon. The attempts to exceed the degree of purity afforded by the best technical electrographite failed, however, for the time being.

The most important progress in the uranium project was achieved during the year 1941. Initially some negative results were recorded. Thus, the enrichment of U(235) by the Clausius–Dickel thermal diffusion method, using gaseous UF_6, proved impossible (Fleischmann, Harteck and Groth). The absorption cross-section for neutrons of the highest purity electrographite was determined in the Kaiser Wilhelm Institute at Heidelberg (Bothe and Jensen[4]), and the behaviour of pure carbon estimated from the results. It appeared, according to the information then available, that even the purest possible carbon was unsuitable for the construction of a uranium pile; whereas, as is well known, carbon has been used in the United States with complete success. Whether the Heidelberg conclusions were falsified by insufficient consideration of the chemical impurities present in commercial graphite (for example, hydrogen or nitrogen), or by deficiencies in the theory, can scarcely be assessed for the moment. In any event, the Heidelberg experiments on graphite and beryllium (Fünfer and Bothe[8]) made it clear, in connexion with

later experiments in the Berlin–Dahlem Institute, that both pure carbon and pure beryllium were highly suitable for use as an outer cover for a uranium pile, inasmuch as their low absorption cross-section and high reflecting power restrict the spread of the neutrons escaping from the pile, thus reducing its minimum dimensions.

In the summer of 1941, 150 litres of heavy water were available for the first experiments on a neutron-injected pile built up of uranium and heavy water (Döpel and Heisenberg, Leipzig). The uranium and heavy water were arranged in alternate spherical layers with the neutron source at the centre. The oxide U_3O_8 which was first employed produced only a slight increase in the number of escaping neutrons, which could scarcely be considered a clear proof that $k > 1$. The use of pure uranium metal, however, gave such a decided improvement that no further doubt of a real increase in the number of neutrons ($k > 1$) was possible (about February or March 1942). Here then was the proof that the technical utilization of atomic energy was possible, and that the mere enlargement of the Leipzig apparatus must furnish an energy-producing uranium pile.

At the same time, important administrative changes were taking place. At a meeting held in the building of the Reichsforschungsrat in Berlin, on February 26, 1942, the results to date were reported to the Minister of Education, Rust, and several directors of war research. The uranium project was transferred from the Heereswaffenamt to the control of the Reichsforschungsrat; and the then president of the Physikalisch-Technische Reichsanstalt, Esau, was made responsible for the project. On June 6, 1942, there was a second meeting at Harnack House in Berlin, when the results of the uranium project were reported to Speer, as Minister for War Production, and to the armament staff.

The facts reported were as follows: definite proof had been obtained that the technical utilization of atomic energy in a uranium pile was possible. Moreover, it was to be expected on theoretical grounds that an explosive for atomic bombs could be produced in such a pile. Investigation of the technical sides of the atomic bomb problem—for example, of the so-called critical size—was, however, not undertaken. More weight was given to the fact that the energy developed in a uranium pile could be used as a prime mover, since this aim appeared to be capable of achievement more easily and with less outlay. As to the separation of the uranium isotopes, no method was known which would have allowed of the production of an atomic explosive without an enormous and therefore impossible technical equipment. Incidentally, the use of protoactinium as an atomic explosive was also considered, since its nucleus is fissionable by neutrons with energies down to 10^5 eV., with the consequent possibility of a fast chain reaction. It was, however, considered to be impracticable to prepare the necessary quantities of the element.

Following this meeting, which was decisive for the future of the project, Speer ruled that the work was to go forward as before on a comparatively small scale. Thus the only goal attainable was the development of a uranium pile producing energy as a prime mover—in fact, future work was directed entirely towards this one aim. Again during the summer of 1942, discussions were held with heat experts on the technical problems of heat transfer from the uranium to the working material (that is, water or steam). Technical experts from the Navy attended the meeting with a view to the possible use of a uranium power unit in warships. The Kaiser Wilhelm Institut für Physik was restored to the Kaiser Wilhelm Gesellschaft, with the author as director. In preparation for investigations on the larger uranium piles planned in the Institute, a spacious underground laboratory was added (Wirtz).

About this time, however, the strain of the War on the already overloaded German industry was making itself felt. Uranium and uranium slugs were produced in such small quantities that deliveries were late and the larger-scale experiments were repeatedly postponed. Nevertheless, important progress was made. As early as 1941, a research group at the Heereswaffenamt (Diebner, Pose, Czulius) had made measurements on a large pile built up as a lattice of uranium cubes in a paraffin matrix; the subsequent theoretical investigation (Höcker) demonstrated that the lattice construction could in certain circumstances show advantages over the layer arrangement. An experiment made by this group with a model pile of uranium cubes in D_2O ice did, in fact, yield a larger increase in the number of neutrons than the Leipzig pile. In a later experiment, using 500 litres of heavy water, a further increase in the number of neutrons was recorded. Measurements made in the Heidelberg Institute with a small model pile defined the relation between the increase in the number of neutrons on one hand, and the thickness of the layers on the other; while experiments undertaken by Bothe and Flammersfeld at Heidelberg, and by Stetter and Lintner in Vienna, threw new light on the fission processes occurring in U(238). A theoretical investigation by Bothe stressed the importance of the 'stopping distance' (*Bremslänge*) for the minimum size of a self-sustaining pile.

In preparation for further experiments with larger quantities of heavy water and uranium metal, the Kaiser Wilhelm Institut für Physik in Berlin began a study of the effect of graphite and water as an outer cover for the pile. Resonance absorption in uranium had been studied by Volz and Haxel and by Sauerwein. Further, the absorption cross-sections of a series of different substances were measured by Ramm, as well as by Volz and Haxel at the Berlin Technical High School. As regards the question of thermal stabilization of the energy production resulting from the temperature broadening of the resonance lines, experiments by Sauerwein and Ramm with the Berlin-Dahlem high-voltage plant were significant.

In the spring of 1943, the Norsk Hydro electrolytic plant was put out of action in a Commando raid. Its reconstruction was begun, but finally the responsible army command in Norway reported that effective protection of the plant, particularly against air raids, was impossible. In October 1943 the plant was completely destroyed in a heavy air raid. Nevertheless, about two tons of heavy water were available in Germany at the time: a quantity which, according to our calculations, was just enough for the construction of an energy-producing pile. The Reichsforschungsrat had made no effective provision for the construction of a new heavy water factory in Germany, and the pilot plant at I.G. Leuna made slow progress. It was proving, in fact, barely possible, in view of air raids and the overall strain on German production, to undertake such big building projects. The production of uranium slugs came to a temporary standstill after the raids on Frankfurt in the spring of 1944.

Even then, some progress was achieved by the Harteck–Groth–Beyerle group. As early as 1942, this group had succeeded in developing an ultracentrifuge for the enrichment of the isotope U(235). It was planned to use uranium enriched with the rare isotope in the construction of improved uranium piles, possibly in conjunction with ordinary water. At about this time, the direction of the uranium project was transferred from Esau to Gerlach. Gerlach had taken over the physics section of the Reichsforschungsrat, and he strove to promote more particularly the scientific side of the uranium problem; and at that, not only the physical, but also the medical aspect. In connexion with the medical applications, the construction of a low-temperature pile, in liquid carbon dioxide, was undertaken on Harteck's suggestion. Such a pile, even of small dimensions, could be expected to yield profitable amounts of radioactive elements for tracer research, in view of the decreased absorption in the resonance lines at low temperatures.

In the winter of 1943–44, a model pile of 1·5 tons of heavy water and about the same weight of uranium plates was constructed in the Dahlem air-raid shelter through the co-operative efforts of the Kaiser Wilhelm Institutes for Physics in Berlin and Heidelberg (Wirtz, Fischer, Bopp, P. Jensen, Ritter). The number of neutrons injected from the internal source was multiplied by the factor 3, a performance approaching considerably nearer to what we called the *Labilitätspunkt*, at which the ratio k increases beyond limit and at which the uranium pile begins to radiate independently of the neutron source and thus to produce energy. The relation between neutron increase and layer thickness fulfilled expectations. Further, the stopping distances of the fission neutrons in carbon and heavy water were redetermined (Wirtz) and the former inexact measurements considerably improved. These experiments were made in the air-raid shelter of the Institute during the heaviest air raids on Berlin, and were naturally to some extent hindered by the raids. On February 15, 1944, the Kaiser Wilhelm Institut für Chemie received a direct hit. In the meantime, the Kaiser Wilhelm Institut für Physik had been partly evacuated to Hechingen. On the instructions of Gerlach, a cellar cut out of the solid rock, situated in the village of Haigerloch, was equipped for the rebuilding of the uranium pile. It was not until February 1945, however, that the greater part of the necessary material (about 1·5 tons of heavy water, 1·5 tons of uranium, 10 tons of graphite, cadmium for the regulating rods, etc.) was finally assembled at Haigerloch, and a new pile, this time built up of uranium cubes in heavy water, with an outer cover of graphite, constructed (Wirtz, Fischer, Bopp, Jensen, Ritter). A branch of the Reichsforschungsrat at Stadtilm was allotted the remaining quantity of heavy water and a great part of the available uranium. The Haigerloch pile yielded a sevenfold neutron increase. The material available at Haigerloch, however, was just insufficient to attain $k = \infty$. A relatively small amount of uranium would in all probability have sufficed; but it was no longer possible to obtain it, since transport from Berlin or Stadtilm could no longer reach Hechingen. On April 22, Haigerloch was occupied, and the material confiscated by the Americans.

When we compare the German work reported here with the corresponding Anglo-American effort, so far as it has been made known, then the beginning of 1942 seems to be the turning point. Up to that time, both sides were dealing predominantly with the scientific problem as to whether nuclear energy could be utilized at all, and what fundamental methods had to be employed to that end. Both sides had arrived almost simultaneously at very similar results, if one excludes the field of isotope separation, in which the Anglo-Americans had made much greater progress. Furthermore, in the United States far more attention had been given to laying the groundwork for subsequent full-scale development of the uranium project; so that the first self-supporting pile was functioning as early as December 1942.

It remained to determine the technical sequel to these results. In the United States, the final decision was taken to go for the production of atomic bombs, with an outlay that must have amounted to a considerable fraction of the total American war expenditure; in Germany an attempt was made to solve the problem of the prime mover driven by nuclear energy, with an outlay of perhaps a thousandth part of the American. We have often been asked, not only by Germans but also by Britons and Americans, why Germany made no attempt to produce atomic bombs. The simplest answer one can give to this question is this: because the project could not have succeeded under German war conditions. It could not have succeeded on technical grounds alone: for even in America, with its much greater resources in scientific men, technicians and industrial potential, and with an economy undisturbed by enemy action, the bomb was not ready until after the conclusion of the war with Germany. In particular, a German atomic bomb project could not have succeeded because of the military situation. In 1942, German industry was already stretched to the limit, the German Army had suffered serious reverses in Russia in the winter of 1941–42, and enemy air superiority was beginning to make itself felt. The immediate production of armaments could be robbed neither of personnel nor of raw materials, nor could the enormous plants required have been effectively protected against air attack. Finally—and this is a most important fact—the undertaking could not even be initiated against the psychological background of the men responsible for German war policy. These men expected an early decision of the War, even in 1942, and any major project which did not promise quick returns was specifically forbidden. To obtain the necessary support, the experts would have been obliged to promise early results, knowing that these promises could not be kept. Faced with this situation, the experts did not attempt to advocate with the supreme command a great industrial effort for the production of atomic bombs.

From the very beginning, German physicists had consciously striven to keep control of the project, and had used their influence as experts to direct the work into the channels which have been mapped in the foregoing report. In the upshot they were spared the decision as to whether or not they should aim at producing atomic bombs. The circumstances shaping policy in the critical year of 1942 guided their work automatically towards the problem of the utilization of nuclear energy in prime movers. To a German physicist, this task seemed important enough. The mere possibility of solving the problem had been rendered possible by the discovery of the German scientific workers Hahn and Strassmann; and so we could feel satisfied with the hope that the important technical developments, with a peace-time

application, which must eventually grow out of their discovery, would likewise find their beginning in Germany, and in due course bear fruit there.

[1] *Naturwiss.*, **27**, 11 (1939).
[2] *Nature*, **143**, 470 (1939).
[3] *Naturwiss.*, **27**, 402 (1939).
[4] *Nature*, **143**, 239 (1939).
[5] *Z. Phys.* **119**, 696 (1942).
[6] *Z. Phys.*, **120**, 450 (1943).
[7] *Z. Phys.*, **119**, 568 (1942).
[8] *Z. Phys.*, **122**, 749 (1944).
[9] *Z. Phys.*, **122**, 769 (1944).

Publication of results for which no source is cited was prohibited during the War.

A LONG-TERM PLAN FOR THE NILE BASIN

EGYPT, an agricultural country with practically no rainfall, is entirely dependent on the annual flooding of the Nile. Under natural conditions only that part of the country could be cultivated which was reached by the flood waters, and as the bulk of the population was generally little above the subsistence level, a poor flood meant widespread famine. The area of cultivation could only be extended by irrigation of land not reached by the natural flood; that is, by constructing dams to raise the level of the water, without interfering with the maximum level of the flood further downstream. The study of this possibility was begun about 1890 by Sir William Willcocks, as a result of which a relatively small dam was built at Aswan. This was completed in 1902, but was soon found to be inadequate; no other suitable site could be found at the time and the Aswan dam was heightened in 1912. Since 1920 the study of the Nile Basin has been assigned to the Physical Department of the Ministry of Public Works, Egypt, under the director-general, Dr. H. E. Hurst, who has gradually pushed investigations farther and farther upstream to the head-waters of the river in Lake Victoria in Uganda and Lake Tana in Abyssinia. From 1931 onwards a comprehensive series of reports has been issued under the title "The Nile Basin"; the present volume, by H. E. Hurst, R. P. Black and Y. M. Simaika, is the seventh of the series*.

The earlier proposals considered only how to make the best use of the flood water year by year. Storage from one year to another on the Nile itself presented very great difficulties, partly because of the immense volume of storage required to allow for a run of poor floods, and partly because of the enormous loss by evaporation in Egypt. Consequently, a poor flood still caused very great hardship; the situation was not so bad as it might have been because the Nile draws its water from a very large basin, and the fluctuations of rainfall were not in general similar over the whole area; but this advantage is largely offset by the losses in the extensive marshes of the Sudd. The Bahr el Jebel, which carries the whole of the discharge of Lake Albert, averaging 25 milliards (thousand millions) of cubic metres a year, flows through the flat Sudan plain, where it loses nearly half its water by evaporation and transpiration. Owing to this loss, the contribution of the White Nile to the main stream is relatively unimportant, and the bulk of the water supply of Egypt has to be met by the Blue Nile alone.

The population of Egypt is increasing rapidly, and the only way to guard against future famine is to accumulate a reserve of water so large that it can provide against the worst succession of bad years to be expected on any reasonable basis. This reserve must be in regions where evaporation is relatively small compared with that in Egypt, where the volume of water can be increased to a sufficient extent without greatly increasing the evaporating surface, and far enough apart for the variations from year to year to be practically independent, so that runs of bad years would not be likely to coincide in all areas. The authors find that these requirements can be met by dams at Nimule below Lake Albert and at the outlet of Lake Tana, with possibly at a later stage a further reserve in Lake Victoria. The amounts of storage considered necessary, after allowing for the loss of some 40 per cent on the long journey to Aswan, are enormous; they vary slightly according to different details in the plans but roughly amount to 140 milliards of cubic metres in Lake Albert and Lake Victoria together, with afterwards another 40 milliards, and anything up to 17 milliards in Lake Tana. Compared with these figures the capacity of the first Aswan dam, one milliard cubic metres, is indeed "a trifling amount". In order to reduce the losses in the passage of the Sudd, it will also be necessary either to dig a diversion canal or to embank the Bahr el Jebel. The scale of the problem is shown by the length of the proposed canal—about 300 km. or nearly 200 miles. The ramifications are endless, ranging from consideration of the disturbance of dock and harbour facilities to the need to remove and rebuild churches. The cost would be very high, but against it must be set not only the livelihood of many more people in Egypt but also the prevention of flooding and the supply of hydro-electric power. These details are matters for a full engineering inquiry; but the authors have given a lead in what must be one of the most gigantic plans ever seriously put forward.

There is one detail which requires to be mentioned here. The authors repeatedly emphasize their idea of "Century storage", which briefly means that the reserve must be sufficient to deal with the greatest accumulated deficit to be expected in a hundred years. To obtain this figure, they examined a collection of about sixty long records of discharges, river-levels, rainfall, temperature and pressure, ranging from 10 up to as many as 200 years (with one river-level record of 400 years), and plotted the greatest accumulated departures from the mean values against the square root of the number of years. They write: "If we have N observations of an element whose standard deviation is σ, then if R is the maximum accumulated excess or deficit from the mean, on the average

$$R = 1{\cdot}65\,\sigma\,\sqrt{N}$$

. . . The form of this result is confirmed by theoretical investigations based on the theory of probability applied to the tossing of coins." Unfortunately, they do not give the theory, and the reviewer has not been able to find it anywhere in the literature of statistics; but the form of the expression seems to him to be incorrect. It is easily shown that in a series of values obeying the Gaussian distribution, the maximum possible accumulated departure is $0{\cdot}4\ \sigma\ N$, but the value of $0{\cdot}4\ N$ is less than $1{\cdot}65\ \sqrt{N}$ when N is less than 17. Thus, for a series of less than seventeen years, the authors' expression

* The Nile Basin. Vol. 7: The Future Conservation of the Nile. By Dr. H. E. Hurst, R. P. Black and Y. M. Simaika. (Ministry of Public Works, Egypt: Physical Department Paper No. 51.) Pp. xi+178+27 plates. (Cairo: S.O.P. Press, 1946.) P.T. 125; 25s.

gives an expected departure greater than the maximum possible. Detailed calculation would be difficult; but one would anticipate that the maximum deviation expected in N years would bear a constant ratio to the maximum possible deviation, that is, $c\,\sigma\,N$, where c is a constant less than 0·4. Now the accumulated departures in Plate XII only appear to fit in with the $\sqrt{N}$ law because of one very aberrant figure for 400 years; all the remaining points are fitted much more accurately by the curve given by $R/\sigma = 0{\cdot}2\,N$. In a series of a hundred observations, this gives an accumulated departure 20 per cent greater than that estimated by the authors, and their "Century storage" reduces to 80-year storage. This is not actually a very serious matter, as the uncertainties of some of the other figures are probably equally great, but it might be seized on by opponents.

So great a plan will require a long time to come to fruition—time which includes not only the building of the great dams and digging of channels, but also the many years required to build up the reserves of water. Everything depends ultimately on the rainfall of the upper parts of the Nile Basin; but the existing knowledge of the amount of rain and its long-term variation has many gaps, especially in Abyssinia, which must be filled by the setting up of new rain-gauges, and this is one of the first necessary steps. So far as one who is not an engineer can tell, Dr. Hurst and his colleagues have considered all that has to be done and the order of priority, and this should be of great help in the discussion of ways and means.

C. E. P. Brooks

REDUCTION OF FIRE RISKS IN SHIPS

THE Admiralty Chemical Department, Portsmouth, has been busy of late with research into methods of reducing the fire risk on ships arising from paints and other materials used in them. An interim report recently made available reveals that the investigations have followed three lines; namely, the development of fire-retardant paints for interior use particularly on metal surfaces, the fireproofing of textiles, and the fireproofing of plywood and soft timber.

Fire-Retardant Paints for Interior Use on Board Ship

Dried paint films on an organic base can be a powerful factor in transmitting fire, as experience during the War showed. Fire can be propagated from one compartment to another by means of the paint film on the bulkhead between them. Certain paint types when raised to a sufficiently high temperature—on the side of the bulkhead remote from the actual conflagration—blister and form pockets of inflammable vapours. These vapours arise from the partial decomposition of the organic paint medium in the interior of the paint layer. The blisters finally burst, emitting jets of hot gas which ignite spontaneously and burn vigorously, transmitting the fire to any combustible material within reach.

The method used by the Admiralty for evaluating the fire-retardance of paints to be used in such circumstances is as follows. A steel plate, of standard thickness and 12 in. by 12 in. in area, is painted on one side with a primer/top-coat system in the normal manner, adequate time being allowed for drying. The plate is then heated in the vertical position on the unpainted side, with a gas ring supplied with air and gas under standardized pressure. The plate becomes red-hot in about 30 sec. Heating is continued for one minute, by which time combustion of the paint film has largely ceased. Any signs of flashing or flame-propagation are noted, together with any tendency for the red-hot film to detach itself from the plate. This test differentiated decisively between paints of good and bad fire-retardance. Large-scale trials upon painted plates, 6 ft. square, were carried out at the Admiralty Fire Testing Ground, Haslar, and the results established the validity of the laboratory test-procedure.

The tests showed that fire retardance was improved by reducing the proportion of medium so far as was consistent with durability and finish, and that titanium and antimony oxides were particularly effective as pigments in the top coat. The primer used was also important, an aluminium pigmented primer being adjudged to have better fire-retardant properties than a red-lead primer.

A specification for such paints has been prepared which prescribes the type of medium and the minimum proportions of titanium dioxide and antimony oxide to be used, and the correct pigment/medium volume ratio. Fire-resistance and other performance tests are included. Such paint is now in service use, but it has disadvantages, notably its matte surface, and work is at present in hand on the development of a finish of good gloss and adequate fire-retardance.

The experimental conclusion that antimony and titanium oxides are better than the other white pigments tested is interesting, in so far as their behaviour in the heated film must be essentially different; antimony oxide is comparatively volatile and easily reducible on heating with organic matter (such as would be present in the film), and titanium dioxide is particularly inert. Whereas it is admitted that antimony compounds are particularly valuable fire retardants in conjunction with textiles, opinion is divided on the fire-retardant value of antimony oxide in paint; thus an American Report (New York Paint and Varnish Production Club, 1943) on an investigation into fire-retardant paints for steel surfaces says that while in the particular tests reported antimony oxide was useful in preventing flashing in paints of low pigment volume, in paints of high pigment volume (as recommended by the Admiralty) it was the worst of the white pigments examined.

An Inorganic Paint System

Since a paint based on an organic medium can never be entirely incombustible however high the degree of pigmentation achieved, the investigation of paints based on inorganic media was a logical step in the Admiralty investigations. Among the materials examined was cementiferous paint originally developed to make use of the excellent anti-corrosive effect of zinc on steel surfaces and consisting essentially of a zinc oxychloride cement containing a high loading of metallic zinc. Such paint showed great promise as a fire-retardant coating, but in its original form suffered from the following disadvantages: (1) It could not be stored in a ready for use form; it consists of two parts which had to be mixed immediately prior to application. (2) It was highly thixotropic and had poor flow properties. (3) Its colour was a dull grey which could not greatly be improved by the addition of white pigments.

It was found that the first defect could be overcome by the addition of an organic liquid as thinner. Thus 20 per cent by weight of industrial spirit

enabled the paint to be kept indefinitely in a ready-for-use condition, and improved the film properties.

To obtain suitable decorative colours, it was, however, necessary to use the cementiferous paint only as an undercoat and to apply a top-coat in the desired shade. It was found that a partially hydrolysed silicon ester painted over a cementiferous primer gave a paint system which was quite incombustible with excellent weather-resistant and fire-retardant properties. When pigmented with titanium dioxide and barium sulphate the film was hard, matte and white; unfortunately, however, the pigmentation was found to affect the film-forming properties of the silicon ester in a discouraging and inexplicable manner. Whereas the pure medium gave continuous, hard and resistant films, the pigmented films tended to craze and crack on drying, and under the fire test small pieces flew off with considerable violence. Usually the cracking resulted in the under-coat being dragged away from the steel surface, and the whole film became faulty and brittle.

The next step was to consider the old problem of plasticizing the silicon ester paint, and di-butyl phthalate was the most satisfactory material. The films, although matte, did not craze or crack on drying or weathering and had excellent fire-retardant properties owing to the fact that the volatile dibutyl phthalate evaporated quickly when heat was applied, instead of charring and burning. Linseed oil was not so successful as a plasticizer.

The remaining problem in the use of silicon ester paints in the manner described was that of stability, for silicon ester medium, whether pigmented or not, shows a gradual increase in viscosity from the date of preparation until, after about three or four months, it sets to a hard gel. The common preserving agents, such as colloidal electrolytes, appear to be ineffective in this case, and the problem is one of great complexity.

The Admiralty has, in effect, met the customary stumbling-blocks in the use of silicon ester paints. Possibly some improvement may lie in the use which has recently been reported of stable silicon esters which are hydrolysed by the user just prior to application. It does not seem unreasonable to suppose that entirely adequate plasticizers for silicon ester will be found in the silicone field.

Fireproofing of Textiles

It was necessary that attention should be paid to the reduction of the inflammability of the many textile fabrics to be found on board ship.

A water-resistant fireproofing treatment is essential for materials such as ships' awnings, boat covers, etc., which are exposed to the weather, and is preferable for materials such as curtains which need to be laundered. Nevertheless a certain amount of fire-proofing was carried out on ships by impregnation with water-soluble materials, borax–boric acid mixtures being preferred; reproofing after washing is necessary.

There is no simple method of producing an adequate water-resistant fireproofing treatment by deposition of insoluble inorganic materials in the fibres. Some metallic oxides, for example, iron and tin, which provide efficient flame-resistance when so deposited, unfortunately induce considerable after-glow.

In the Admiralty work the best results were achieved by impregnation with antimony oxide in conjunction with a chlorinated organic compound such as chlorinated paraffin or polyvinyl chloride co-polymer. The after-glow usually associated with such processes was reduced by the incorporation of zinc oxide or stannic phosphate to provide a fire-, water- and weather-resistant process suitable for application to cotton fibres and flax canvases. Large-scale trials demonstrated that the treated fabrics retained a fair degree of flexibility and were very nearly glowproof.

Owing to the somewhat copious evolution of smoke on ignition, it was found that the application of the process on fabrics normally situated between decks was restricted; but for canvas gear, for example, weather screens, etc., more or less permanently fitted on the weather deck, the process was strongly recommended.

In addition to the use of fire-proofing processes, attention was paid to the use of less inflammable textile materials. For example, consideration was given to the replacement of cotton by wool, nylon or alginate according to the circumstances. Glass-fibre fabrics proved insufficiently durable under sea-going conditions.

The report under review, taken with other information, shows that the war years have brought antimony oxide, previously neglected, to the forefront as a constituent of fire-proofing compositions on textiles. Antimony oxide, while of itself having only moderate fireproofing properties (it is not completely inert as suggested by the Admiralty report under notice), has greatly enhanced fireproofing properties in the presence of chlorinated organic compounds (usually attributed to the formation of antimony oxychloride), and also other materials such as iron oxide; and it is as a result of these discoveries that its use has been advanced.

Rapid Methods for Fireproofing Plywood and Soft Timber

In May 1944, work was commenced to devise an efficient method of fire-proofing small wooden articles such as, for example, plywood used in the construction of cases for radio equipment.

The standard method of fire-proofing wood in bulk by impregnation with mono-ammonium phosphate solution was found not to be very suitable owing to the relative slowness with which aqueous solutions are absorbed by wood; and moreover, in the case of plywood, the use of aqueous solutions would cause distortion through attack on the adhesives. This directed attention towards a fire-proofing agent which should be soluble in organic solvents, and in turn led to an examination of the suitability of organic phosphates for the purpose in view. Examination of a large range of materials showed that urea phosphate, which is readily soluble in alcohol, possessed good fire-proofing properties; and an alcoholic solution with a small proportion of wetting agent added was found to give the desired speed of impregnation.

The most satisfactory procedure involved simple immersion of the article to be treated in a hot solution (of 20–30 per cent strength by weight) of urea phosphate in industrial methylated spirits for approximately one hour. The excess was then allowed to drain off, and the article left to dry. Alternatively, though less satisfactorily, in cases where immersion is impracticable, a series of brush applications can be substituted. Large-scale trials at the Admiralty Fire Testing Ground, Haslar, confirmed the efficiency of the process, which has been patented and assigned to the Admiralty.

L. A. JORDAN

NEWS and VIEWS

International Council of Scientific Unions

Executive Committee's Annual Meeting

THE Executive Committee of the International Council of Scientific Unions held its annual meeting in Paris in July at U.N.E.S.C.O. House under the chairmanship of Prof. Němec of Prague. Dr. Laves, deputy director-general of U.N.E.S.C.O., in welcoming the Committee, stressed the importance that U.N.E.S.C.O. attached to mutual international understanding and to the well-being of all the nations of the world. He hoped that the Committee would devote some attention to the social implications of science. Nine international scientific Unions were represented at the meeting, including two new Unions which had been admitted as adhering organisations during the previous twelve months—the International Unions of Crystallography and of Theoretical and Applied Mechanics. A tenth Union was admitted at the meeting, the International Union of the History of Science. No new Joint Commissions between the Unions were formed, but instead it was agreed that one Union should form a committee in a border-line subject and invite other interested Unions to nominate members of the Committee. In the same way, it was agreed to allot each of the existing Joint Commissions to a parent Union, which would be primarily responsible for controlling and helping its activities. The Unions were still feeling their way to the best method of helping forward border-line subjects, but one point was clear—representatives of a particular science should be nominated by the appropriate Union, not co-opted by the parent body. Thus a committee on radio-biology in the Union of Biological Sciences would include members nominated by the Unions of Physics and Chemistry.

The Committee expressed gratitude to U.N.E.S.C.O. for grants totalling more than 200,000 dollars to the Council and the various Unions to meet travelling expenses of delegates, to finance well-established international scientific organisations and to meet certain costs of publication and of administration. M. A. Establier was re-appointed liaison officer between the Council and U.N.E.S.C.O. for 1948. Reports were received from the Unions, Joint Commissions and the Committee on Science and Social Relations. These will be published with the report of the Committee to the organisations adhering to the Council.

Report of the 1946 General Assembly

EDITED by Prof. F. J. M. Stratton, general secretary, the Reports of Proceedings of the Fourth General Assembly of the International Council of Scientific Unions, held in London during July 22–24, 1946 (see *Nature*, August 17, 1946, p. 227), has now been published (London: Camb. Univ. Press, 1946). It includes the presidential address of Prof. H. R. Kruyt and of the proceedings at the general assembly, together with the reports of the international unions. Appendixes include a list of delegates, the report of the executive committee and the draft agreement with the United Nations Educational, Scientific and Cultural Organisation, the financial report, the statutes of the International Council of the Scientific Unions and the scientific unions themselves. The names of the members of the mixed commissions and of the officers of the international unions are also given, making the report a useful reference book; while in addition to the report of the Committee on Solar and Terrestrial Relationships, there is also reprinted the report of the Committee on Science and its Social Relations on the public attitude of scientific bodies with regard to the problems raised by recent applications of science.

The report of the Committee on Science and its Social Relations points out that the problem of nuclear energy takes the foremost place at present in all discussions on the relation between science and society, although biochemistry, biology, bacteriology and aerodynamics will present questions of almost equal importance. Emphasizing that science thrives best in an atmosphere of freedom of thought and co-operation, and that the widest interchange of information is vital to its full development, the report urges that the imposition and control of any necessary restrictions of secrecy should be exercised only by constitutional authority and in consultation with, and under the guidance of, representative scientific opinion. The increasing social importance of science must be recognized by scientific workers themselves as fully as by governments and administrators, and it is part of the duty of men of science to urge that the problems of government and administration should be rationally formulated and attacked. They must, collectively and individually, bring to the solution of these problems their devotion to truth and their unswerving, objective and critical search for facts and their interrelations.

York as a University City

IN a letter dated July 8, 1947, which is addressed to those who have expressed interest in the project of a university foundation in York, the Lord Mayor makes clear the policy being pursued by the University Grants Committee. Although that Committee has expressed agreement with the view "that the City of York is in many respects well suited to be a centre of university education", it has drawn a rigid line between the "short-term" and the "long-term" prospect. It appears that immediate prospective needs can, in the opinion of the Committee, be met by plans for the extension of existing university institutions—"provided they can be assured of additional academic staff in sufficient numbers and of the means of carrying out an extensive programme of new building." Clearly, therefore, the University Grants Committee has already determined that, whether at York or elsewhere, there is little case for the establishment of a new university centre "at any time in the near future". It is, of course, as the Committee points out, open to the local community to proceed to work out the details of a scheme which might form the basis of a long-term policy, should conditions materially change after five or ten years; and it is encouraging to know that an executive committee has already been set up in York to undertake the preparation of detailed plans.

A National Council for Further Education

As a step towards the further implementation of the recommendations made in the report of the Percy Committee on Higher Technological Education, the Ministry of Education has set up a working party to consider the functions and institution of a National Council to co-ordinate the work of Regional Advisory Councils for Further Education. The members of

the working party are: Mr. D. R. Hardman, parliamentary secretary to the Minister of Education (*chairman*); Mr. C. N. Gallie, Mr. F. W. Lawe, Mr. S. Hurst, Captain A. M. Holbein, Mr. H. S. Magnay, Dr. J. E. Myers, Prof. E. A. Owen, Prof. R. E. Priestley, Dr. H. Schofield, Sir Charles Tennyson, Mr. T. B. Wheeler, Mr. F. Bray, Mr. H. J. Shelley, Mr. I. O. McLuckie (*secretary*).

Current Aspects of Sociology

THE issue of *Pilot Papers* for March 1947 (2, No. 1), is an admirable mixture of the methodological, the statistical, the philosophical and the human interest in sociology, all of unusual calibre and neatly compèred by Mr. Charles Madge. Two statistical articles illustrate how statistics may lay bare truths obscured by wishful thinking. For example, Mr. J. F. S. Ross shows, as against popular misconception, that the present House of Commons is little younger than previous Houses, and Dr. Grace Leybourn-White that only one in five of those with an intelligence quotient of 124 or more (equal to that of the best half of Manchester students) actually reach the universities. The philosophical contribution by Dr. H. W. Singer (incidentally a statistician) reflects upon social progress, and rightly questions the popular, and sometimes academic, view that economics is wholly concerned with material wealth and prosperity. Human interest is supplied by E. L. Packer's "Aspects of Working-Class Marriage". As a probation officer, he brings wide experience; but clearly the stage is not yet set for even a statistical *estimate* of the relative frequency of the various patterns of marital life he discloses. In Mr. Willson Disher's "Penny Dreadfuls", with many of the original illustrations and three chapters from the "Blue Dwarf", human interest is at highest pitch.

Among the 'coldly' scientific, however, it is the methodological article by Tom Harrisson on "What is Sociology" that will arouse most interest. He cries plague upon both the purely philosophical and deductive, and the purely statistical and inductive approach in sociology. But surely, while deduction and philosophy have little use for mass-observation, statistics are perfectly compatible with it. Statistical measurement is indeed logically the next stage in induction after observation, not a rival method at the same stage. Mr. Harrisson should have every support in insisting on more 'penetrative' observations; but after that, how can mass behaviour be summed up or the relative frequency of its various patterns be estimated except by statistics? While supporting statistics, he should urge that we ought to be less eager to rush into statistics before making sure of the stuff our statistics are made of. Occasionally, too, he is unfair—particularly so to industrial psychologists and sociologists. They are not talking of incentives merely now that it is fashionable, as a new discovery. On the contrary, if Mr. Harrisson will look at the index of books on industrial fatigue so far back as 1923, he will find 'incentives' with many references; or let him read some of the inter-war reports of the Industrial Health Research Board. The industrial psychologist has, in fact, been for many years a voice crying in the wilderness.

German Hydrographic Journal

A NEW journal is to be issued by the German Hydrographic Institute, now at Hamburg, under the title *German Hydrographic Journal*. This will be the medium for the publication of articles on those branches of science which are the concern of the German Hydrographic Institute; such as coastal and open sea surveying, nautical science, navigation, chronometry, terrestrial magnetism, ship's magnetism, nautical technique, tides, and physical and chemical oceanography—the latter including reports on the geology and lithology of the sea-bottom. The *Journal* will, in effect, so far as the subjects named are concerned, take the place of the former *Annalen der Hydrographie und Maritimen Meteorologie*, which were published by the German Admiralty during 1873–91, and thereafter by the Deutsche Seewarte up to 1944. Maritime meteorology and climatology, being now the concern of the Meteorological Office for North-Western Germany, will be dealt with in the new journal only in so far as they affect oceanography. Generally, each issue will contain articles on a variety of the subjects named above, and will include also notices on hydrographic institutions and other related matters. In addition, notices and reviews of publications of interest to the Institute will appear in the pages of the journal, together with a current bibliography relating to the special fields of research enumerated. An ultimate aim is gradually to list all relevant German and other publications which have appeared since the autumn of 1939, though such a bibliography cannot be compiled in proper time sequence. The journal will appear under the supervision of Dr. G. Boehnecke (who is the German director of the Institute), and will be edited by Dr. Arnold Schumacher.

Science in Poland

ACCORDING to a writer, Prof. Adam Malicki, in the new Polish monthly review, *Zycie Nauki*, May 1946, two plans are now being considered in connexion with science in Poland. One envisages the transforming of certain Polish universities (there are seven at present functioning) into higher professional training schools; the other involves an increase in the number of research institutes outside the universities. Past experience is said to have led to the conclusion that the acquisition of knowledge in a certain subject by a student is of less value than the gaining of an insight into the methods of scientific investigation and the solving of special problems. These objects can be best achieved by constant contact with creative men of science and by team-work in research. There may be difficulties in filling immediately all the posts at Polish universities, but their proper functioning is a matter of urgency on account of the large number of students enrolled. Another contributor, Dr. J. Parnas, urges that all research institutes should be placed under the supervision of the Polish Academy of Science and Letters, which should co-ordinate all investigations.

Zycie Nauki, which gives an idea of the outlook for science in Poland, is edited by Mr. M. Choynowski of Cracow, who states that in future the journal will contain a short review in English of scientific life in Poland. In this issue there is a summary of information on atomic energy taken mainly from the *Economist* and *Discovery* and reference is made to the cultural co-operation of the British Council and to its *Monthly Science News* and the *British Medical Bulletin*. Another article, by Stanislaw Liwszyc-Tomasik, is devoted to "the organisation of medicine in Great Britain", which the author thinks has undergone considerable change during the last two or three decades.

Medical Rehabilitation

A BOOKLET published by the Ministry of Health entitled "The Road Back to Health" (H.M. Stationery Office, 1947. 6*d*.; 7*d*. including postage) describes the process called rehabilitation by which injured or sick people are cared for, right from the beginning, with the object of returning them eventually to as full a measure of health and activity as is possible. The booklet tells its story well, and readers of it will be surprised by the degree of useful activity and happiness which can nowadays be conferred upon people whose injuries or illnesses used to cripple them and hasten the end of life. Excellent photographs show patients undergoing this continuous and beneficial treatment, facilities for which are available now at more than three hundred hospitals in England and Wales. Nobody can look at these or read the text of this booklet without commending both the present work and the plans for its future which are outlined in a concluding chapter. The booklet is intended chiefly for hospital authorities, doctors, employers, welfare workers and others closely associated with the care of the sick and injured; but the co-operation of everyone in this work is required, and especially that of the patient, so that the more the general public learn about it the better. The loss of a lung or an apparently irremediable injury of a vital limb or joint need no longer condemn either man, woman or child to be a life-long cripple or dependent on others. Modern medicine and surgery have given us in recent years many spectacular benefits of mankind and most of them have been well and extensively interpreted to the public. Rehabilitation is not so well known or understood. It depends upon the patient and highly skilled co-operation of doctors, nurses and others, and cannot succeed without the active help of the sick or injured person. It is a service to mankind which must be classed as one of the greatest achievements of modern times.

Seismology at Oxford

MISS E. F. BELLAMY, well known for her seismological work, has retired from her post as assistant at the Oxford University Observatory. It is hoped that she will enjoy a long and congenial retirement. The connexion between the Oxford University Observatory and seismology which was effected by the late Prof. H. H. Turner, enhanced by Prof. H. H. Plaskett and cemented by Miss Bellamy and others is being severed. The centre, where the calculations are done before the publication of the International Seismological Summary, has already been moved, by courtesy of the Director of the Meteorological Office, Air Ministry, to Kew Observatory, Richmond, Surrey.

The two Milne-Shaw seismographs belonging to the British Association Seismological Committee have been moved to Charles Darwin's old home at Down House, Downe, Kent (latitude 51° 19′ N., longitude 0° 4′ E.) and put in charge of Dr. O. J. R. Howarth, who, until recently, was secretary of the British Association for the Advancement of Science. Dr. Howarth is setting up the instruments on pillars in the basement of the house and hopes to bring the seismographs into use shortly. Down House is situated on a clay-with-flints cap over the chalk of the North Downs.

Weather Control Predicted

Sky and Telescope for April contains a short note on this subject in connexion with an address by Dr. V. K. Zworykin before the U.S. Institute of Aeronautical Sciences. He pointed out that new electronic calculators will yield rapid results regarding weather forecasts, and it may be possible to alter the weather by the release of a relatively small amount of energy which will have a 'trigger' effect. One method suggested is to spread a large amount of oil on water and ignite it; the resulting updraught would then change the motions of the higher-level air masses. Another method would utilize solar radiation at 'weather control areas', these consisting of large absorbing areas blackened by carbon deposits. These could be easily changed when desirable into highly reflecting areas by the formation of artificial fogs.

Announcements

MR. N. B. KINNEAR, the well-known ornithologist, keeper of zoology in the British Museum (Natural History) since 1945, has been appointed director of the Museum in succession to Sir Clive Forster-Cooper, who retires on October 1.

NATIONAL RESEARCH CORPORATION, Cambridge, Mass., in co-operation with the Division of Industrial and Engineering Chemistry, American Chemical Society, is arranging a symposium on "High Vacuum" to be held in Cambridge, Massachusetts, during October 30 and 31. Attendance will be restricted to technical and scientific personnel concerned with industrial applications of high vacuum. A report and the papers will be published in due course in *Industrial and Engineering Chemistry*. The secretary of the symposium is Mr. Stanley Heck, National Research Corporation, Cambridge 42, Massachusetts.

PUBLICATION No. 15 of Messrs. C. A. Parsons and Co., Ltd., Heaton Works, Newcastle-upon-Tyne 6, is an illustrated four-page pamphlet describing the Sir Howard Grubb, Parsons and Co.'s infra-red gas analyser, the operation of which depends on the fact that most of the common gases have strong absorption bands in the infra-red region of the spectrum. Each instrument is complete with one detecting unit filled with a particular gas, but additional units filled with other gases can be supplied and the replacement made by the user in a minute or two. Gases which can be estimated with the apparatus include carbon monoxide, carbon dioxide, methane, ethylene and other hydrocarbon gases.

WE regret to announce the following deaths:

Dr. John Parkinson, known for his geological work in various parts of Africa, Trinidad, India and Burma, on July 19, aged seventy-five.

Mr. R. I. Pocock, F.R.S., superintendent of the Zoological Society's Gardens, London, during 1904–23, on August 9, aged eighty-four.

Sir William Thomson, professor of mathematics in Victoria College, Stellenbosch, during 1883–95, principal of the University of the Witwatersrand, Johannesburg, during 1924–28, on August 6, aged ninety.

Prof. W. W. Watts, F.R.S., emeritus professor of geology in the Imperial College of Science and Technology, London, on July 30, aged eighty-seven.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Abnormal Flower Development in Barley Involving Sex Reversal

REPORTS have appeared in the press of widespread sterility in barley grown in East Anglia, and crop failure has been feared. The appearance of 'multiple ovaries' was noted by A. W. Punter, as reported by F. G. C. Fison[1]. Specimens of such abnormal ears were sent to us by Mr. Punter on July 10, which, on examination, disclosed the following facts.

About half the spikelets in the affected ears contained swelling grain and appeared to be normal. The sterile spikelets are easily distinguished from these by the widely opened glumes, exposing one or more undeveloped 'ovaries'. The presence of the rachilla indicates that not more than one flower is concerned. Supernumerary 'carpels' from one to three are present, and there is little doubt that these constitute the staminate whorl of the flower. In various flowers transitional stages were found between normal functional and fertile anthers and completely 'metamorphosed' stamens with many of the characteristics of carpellate structures. In Fig. 1 such a series is pictured. Fig. 1 (*a*) represents a stamen taken from a spikelet of normal aspect with swelling grain ; the stamen when examined was nearly empty and had presumably produced fertile pollen. The peculiarity of the stamen is the appearance at the distal end of unusual simple hairs similar to those found normally on the carpel, and thus suggests the first stage of transition from a normal anther to a carpellate structure. In 1 (*b*) the stamen shown has, in addition to the unbranched hairs already referred to, 'stigmatic hairs' at the apex. In this stamen a few pollen grains were seen at the time of examination; but the flower was sterile and the glumes wide open. In 1 (*c*) the transition has proceeded further ; there was here no sign of pollen, and the anther lobes are expanded as a white swollen tissue resembling that of the apical portion of a normal ovary. In all these cases the filament is long and thread-like as in the normal stamen, but in 1 (*d*) the filament is shortened and thickened. In 1 (*e*) the 'stamen' superficially resembles a normal ovary, but the ovary wall has not fused at the edges and is a hollow cylindrical sac without trace of an ovule : in no instance so far has any ovule been found in such a 'carpellate' stamen, though it is not absent from the accompanying ovary of the flower.

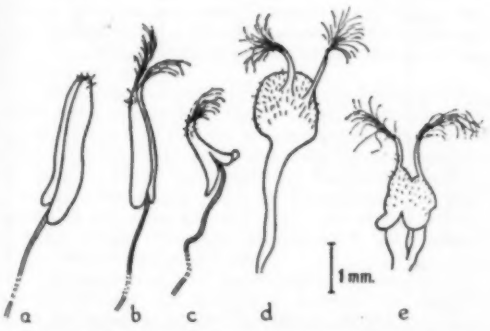

Fig. 1. A SERIES OF STAMENS SHOWING PROGRESSIVE TRANSFORMATION FROM NORMAL TO 'CARPELLOID' DEVELOPMENT
(*a*) Nearly normal stamen with a few simple hairs characteristic of the normal carpel. (*b*) Stamen with normal lobes bearing stigmatic hairs and simple hairs; some pollen formed. (*c*) Stamen with lobes distorted and hypertrophied ; pollen absent. (*d*) Stamen with much-shortened and thickened filament and lobes replaced by a shapeless mass of tissue resembling the colourless tissue below the stigma of the normal ovary. (*e*) 'Carpelloid' stamen with flattened filament shortened to a hollow cylindrical sac resembling the ovary wall. Edges of 'filament' unfused

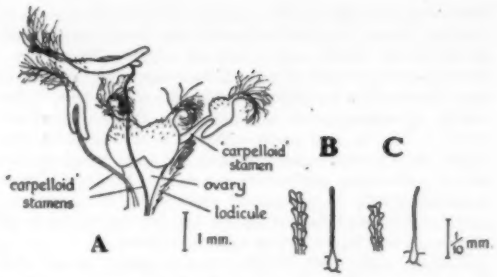

Fig. 2. *A*. COMPLETE ABNORMAL FLOWER SHOWING NORMAL OVARY, THREE CARPELLOID STAMENS AND ONE LODICULE. THE ORIENTATION OF THE STAMENS SHOWS THE ANTERIOR ANTHER TO BE MOST CARPELLATE IN FORM
B and *C*. SIMPLE AND STIGMATIC HAIRS FROM 'CARPELLOID' STAMEN AND OVARY

In Fig. 2 *A* is shown a complete abnormal flower with one of the lodicules, three 'metamorphosed' stamens, and a normal ovary. Fig. 2 *B* shows a 'stigmatic hair' and a simple hair from a carpelloid stamen, and, for comparison, in 2 *C*, similar hairs from the ovary. The identity of the hairs in the two cases emphasizes the resemblance between true ovary and the abnormal staminal structures. Considerable variation occurred in the relative development of the true and 'false' ovaries ; in a few cases the structures were of equal size and then indistinguishable in external appearance.

The occurrence of these abnormal flowers was widespread in the barley fields of East Anglia, but similar abnormalities were also observed by Dr. H. K.

Fig. 3. SWELLING GRAIN TO WHICH IS ATTACHED THE ANTERIOR CARPELLOID STAMEN IN THE FORM OF A 'FALSE OVARY' WITH WELL-DEVELOPED STIGMATIC SURFACE. (× 5)

Porter in experimental cultures of pure-line Spratt Archer grown at Rothamsted in connexion with other work of the Institute of Plant Physiology. Here the separation of the glumes was very marked, accompanied by bending over of the whole ear. The sterile spikelets were exactly like those described above; but in one open spikelet a normal swelling ovary was found accompanied by two small fruits which, however, contained no seed. Spikelets with swelling grain in abnormal ears showed in nearly every case some distortion of the stamens, some of which, however, must have been fertile.

During the past week, in company with Mr. Punter, one of us has examined the present state of the barley over a wide area of Suffolk. The amount of damage caused by the abnormal flower development was found to be quite small. Many of the sterile flowers have now died off but still show on examination remains of the 'carpelloid stamens'. In spikelets adjoining these, swelling grains were sometimes found in which one of the 'carpelloid stamens' persisted closely adpressed and partially fused with the swelling grain and with the white stigmatic tissue still very evident (Fig. 3). These supernumerary 'carpels' were all sterile, but must have responded to the growth stimulus of pollen which was found adhering to the 'stigmatic' hairs. Quite similar grains have been observed in the material from Rothamsted. It thus appears that if any pollen at all is produced in the spikelet, normal development of the ovary follows by self-fertilization and the glumes remain closed. In cases in which no fertile pollen at all is produced, swelling of the tissue below the stigma separates the glumes, and cross-pollination may be effected. The opening of the glumes, which undoubtedly first directed attention in the field to the abnormal floral structures, appears to be a secondary effect of failure of self-pollination, and not a direct effect of the abnormal floral development. That the ovaries of such abnormal flowers can be fertilized and produce normal grain is undoubted, and in consequence the pessimistic reports of the harvest prospects have fortunately proved in large measure groundless.

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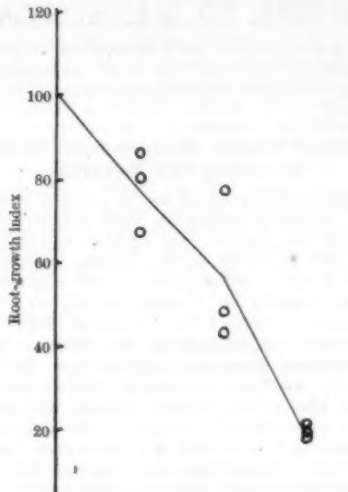
[1] *East Anglian Daily Times*, July 19, 1947.

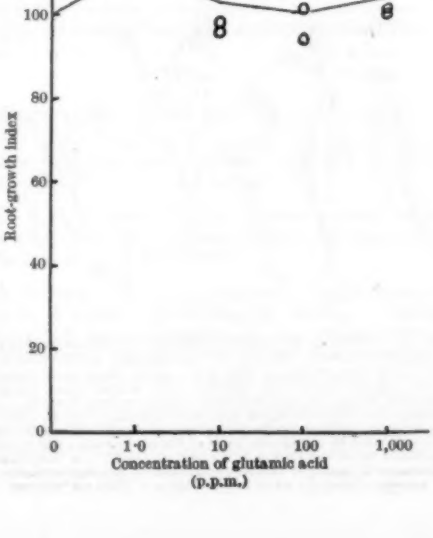
Toxic Effects of Amino-Acids and Amines on Seedling Growth

During the course of experiments on the effect of small concentrations of certain normal metabolites on seedling growth in sterile culture solutions, it has become apparent that a large number of amino-acids and amines have a distinct, and in some cases considerable, toxic action on the growth of cress roots. Experiments have been carried out using the technique described in a previous communication[1]. Sterile cress seeds were grown under rigidly sterile conditions in a range of concentrations of the compounds under consideration, together with controls in normal culture solutions. The various concentrations and controls were usually set up in triplicate, samples of 20 seeds being used in each tube. After a period of 7–10 days growth at 20–22° C. in artificial light (9 hours per day), percentage germination and total weight of roots produced were found for each concentration. From these values the root-growth index was determined. This is equal to

$$\frac{\text{Average weight of roots per seedling in presence of inhibitor}}{\text{Average weight of roots per control seedling}} \times 100$$

and gives a direct indication of the degree of inhibition. Graphs were afterwards constructed relating these values to the concentrations of the substances under consideration.





Two such graphs of root-growth index plotted against a logarithmic scale of increasing concentrations of glutamic acid and tryptophane are given in the accompanying figures. From these graphs it will be seen that glutamic acid exerts no toxic action on root growth up to the highest concentration of 1,000 parts per million. There is even the suggestion of a stimulation at the lowest concentration of 1 part per million. Tryptophane, on the other hand, is definitely toxic at 10 parts per million, the inhibition reaching a value of 80 per cent at the highest concentration of 1,000 parts per million. From graphs such as these, estimations of the relative powers of inhibition of a fairly comprehensive selection of compounds have been obtained and appear in the accompanying table.

Substance	Concentration at which inhibition is detectable (in p.p.m.)	% inhibition of root growth at a concentration of 1,000 p.p.m.
dl-α-Alanine	> 1,000	0
l-Glutamic acid	> 1,000	0
Glycine	100	50
Benzoyl glycine	> 1,000	0
l-Aspartic acid	100	15
dl-Proline	100–1,000	30
d-Arginine	100	30
p-Aminobenzoic acid	100	65
p-Acetylaminobenzoic acid	1,000	14
o-Aminobenzoic acid	10	94
o-Acetylaminobenzoic acid	100	81
p-Aminophenylacetic acid	100	75
p-Aminophenylbutyric acid	100	35
l-Tryptophane	< 10	80
Tryptamine (β-indole-ethylamine)	10	51
Nicotinic acid	10	40
Nicotinamide	10–100	35
Urea	100	75

The following points of special interest are apparent from this table.

(1) The only two normal metabolites so far investigated and mentioned in the table that have no detectable inhibitive action on root growth up to a concentration of 1,000 parts per million are α alanine and *l*-glutamic acid.

It is very suggestive that these two acids are highly active in transaminase systems[2,3]. It is not impossible that other amino-compounds may effect their inhibitions on root growth by competitive interference in the normal transaminase systems of the plant. Further experiments are being undertaken with these possibilities in mind.

(2) Glycine, surprisingly, shows a considerable inhibitive action, but this disappears entirely in the substituted benzoyl glycine (hippuric acid), suggesting that the $-NH_2$ group is essentially concerned in the inhibitive action.

(3) This latter suggestion is partially borne out by results from the amino-benzoic acid series of compounds, where the acetylamino-compounds are seen to be definitely less toxic than the parent amino-compounds. There is a possibility that some hydrolysis may have taken place in the solutions of the acetylated compounds, and that the toxic action observed is due to small amounts of the amino-benzoic acids thus produced.

(4) Tryptophane and tryptamine are known to produce certain physiological actions on plants similar to those produced by the auxins[4,5]. It has always been assumed that these effects are due to the formation from these substances of β-indoleacetic acid (heteroauxin) in the plant tissues subject to their action. In our experiments commercial preparations of tryptophane were used, and it is therefore possible that the observed inhibitions may be due partially to impurities in the form of β-indoleacetic acid. On the other hand, it is most likely that the molecules themselves have a considerable toxicity quite apart from the action of any such impurities that may be present.

(5) It is of much interest that molecules such as urea and nicotinic acid have relatively strong inhibitive effects on seedling growth. Conceivably this is connected with the presence of basic groups in the molecules.

To summarize, a most important feature of these results is the fact that many of the inhibiting compounds are normal plant metabolites. This illustrates the complexity of the problems centred around the nitrogen nutrition of the plant. How far these phenomena will enter into questions concerning organic manuring and the specific effects on plants of organic nitrogen molecules in the soil is a subject for future research.

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Flowering Responses in a Strain of *Orobanche minor*

An interesting case of the dependence of flowering on length of day has been found in *Orobanche minor* growing on red clover. In the first place, data obtained by one of us (P. S. N.) suggested that the time of flowering of this parasitic plant was synchronous with that of the host plant, and was to a large extent independent of the sowing date of the parasite. Late-flowering Montgomeryshire red clover seed was sown at six-weekly intervals from November 1945 until June 1946; *Orobanche* seed was added, through glass tubes already in position in the soil, in some treatments concurrently with the clover seed and in others at each subsequent six weeks interval. The November-, January- and February-sown clovers all flowered in early August, the *Orobanche* appearing in August, September and October, almost independently of the time of sowing of the parasite. The April-, May- and June-sown clovers flowered September to October, and the *Orobanche* attached to them appeared at about the same times.

Clover is a long-day plant, and if it is sown either in spring or the previous autumn it normally flowers in July, August and September, according to the earliness of the variety. In order to study the possible influence of day-length on the flowering of the *Orobanche* an experiment was set up (by M. H.) in 1946, in which pots of clover and *Orobanche* sown in February were exposed to 11 and 16½ hours of controlled day-length. The *Orobanche* was planted at a depth of 2 in. in the soil and was not, therefore, itself exposed to alternating light and darkness.

In short days the clover plants remained vegetative throughout the experiment and were compact and small-leaved. In long days they soon became tall and lax with long petioles, and came into flower in July after 106 days of treatment. *Orobanche* inflorescences appeared only in sets exposed to the long days, the first spike after 134 days exposure and two

others later. The experiment was terminated on August 15, when the total number of *Orobanche* plants found in each treatment, by washing the clover roots free of soil, was 23 in short and 21 in long days. In short-day treatments none of the *Orobanche* plants displayed any signs of flowering on dissection of the growing apices; but of those from long days, in addition to the three already mentioned, seven plants were found to have flower primordia present.

In 1947 a second experiment entirely confirmed these results. It was further observed that the time of germination of the seed and parasitization by the *Orobanche* were independent of day-length. It thus appears that the *Orobanche* on clover does not initiate flowers unless the host is also in the flowering condition.

The times of flowering recorded in the British Flora of Bentham and Hooker for other members of the Orobanchaceæ are consistent with the view that they, too, are synchronous with their host plants in their time of flowering. This relation, however, cannot be postulated for all parasitic flowering plants, for we have shown that *Cuscuta europæa*, L. and *C. gronovii* Willd. flower independently of day-length and independently of the flowering of the host.

On the assumption that flower initiation in the host is controlled by a specific flowering hormone, this is produced only in long-day treatments, must be present in the root, and either it or a precursor appears to be transferred to the tissues of *Orobanche minor*, in which flowering is induced.

A full account of these experiments is being published elsewhere, and studies of *Orobanche* in controlled day-lengths are being continued.

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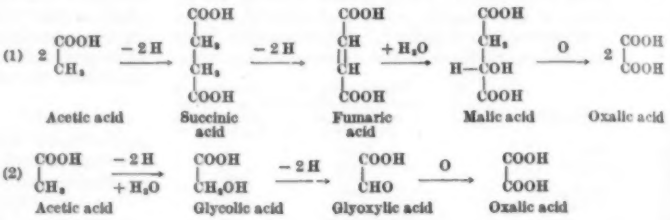
Enzyme Studies on the Mechanism of Wood Decay

Previous studies of the metabolic activities of a group of wood-destroying moulds (*Merulius niveus*, *M. tremellosus*, *M. confluens* and *Fomes annosus*) established the formation of ethyl alcohol, acetaldehyde, acetic and succinic acids by their action on cellulose, glucose and/or xylose[1]. Inasmuch as acetic acid has been shown to be the last breakdown product which can be isolated of the carbohydrate metabolism of these fungi, it was thought of interest to investigate the dissimilation of acetic acid, in the form of sodium acetate, to elaborate the complete phase sequence of wood-cellulose degradation by these moulds.

It was found that oxalic acid is the terminal product of the action of these organisms on acetic acid. The formation of oxalic acid from acetic acid being established, it remained to clarify the pathway of its origin. The discoloration of resazurin when incorporated in the acetate medium, together with a positive test for succinic acid, while pointing to an oxidation of the latter to give rise to oxalic acid, did not exclude the possible simultaneous formation of the acid through another route, since glycolic acid could also be regarded as a dehydrogenation product of acetic acid. Consequently, it was assumed that the discoloration of resazurin indicated a dehydrogenation of acetic acid resulting either in succinic acid, glycolic acid, or both. It would be conceivable, therefore, that *two* pathways can be taken during the formation of oxalic acid from acetic acid, namely:



The action of the *Merulii* and *Fomes annosus* on the following acids was studied: acetic, glycolic, lactic, pyruvic, succinic, fumaric, malic, dimethyl succinic and dimethyl fumaric acids. With the exception of *Merulius confluens*, the organisms were able to produce oxalic acid from all of the acids. It appears, therefore, that the phase sequence of acetate → oxalate transformation proceeds along the pathways outlined above.

Since the same metabolic products (ethyl alcohol and acetic acid) have been obtained from cellulose, glucose and/or xylose by the action of these organisms, we venture to postulate a mechanism for the breakdown of the cellulosic fraction of wood by the action of these moulds. Accordingly the following represents a picture of the sequence of the degradation of cellulose of wood when attacked by these fungi:

Cellulose → Glucose → Ethyl alcohol → Acetic acid → Oxalic acid.

Another mould, *Lentinus lepideus*, also was found to attack wood[2]. On the other hand, we observed that glucose and xylose, too, give rise to methyl-*p*-methoxycinnamate as a metabolic product besides ethyl alcohol during the utilization by this fungus. These findings corroborate the concept of the degradation of the cellulose of wood *via* an introductory hydrolysis when it is decomposed by micro-organisms, since it is only through such a split of the cellulose that glucose can arise as a primary dissimilation product. Then by further action of this mould the synthetic product is formed *via* the free hexose. The facts that xylose (a pentose) also gives rise to the ester, and that ethyl alcohol, obtainable from both glucose and xylose, is rapidly dehydrogenated, prompts the consideration of the transient formation of a C–2 compound in this synthesis which was found to be acetaldehyde. Experiments in which the further transformation of the acetaldehyde was prevented by trapping failed to give rise to the cinnamate.

The similarity between the structure of methyl-*p*-methoxy cinnamate and certain breakdown units of lignin[3] emphasizes the significance of the enzymatic synthesis of the former from acetaldehyde, for the better understanding of the mechanism of lignin formation from carbohydrates in wood, and in the overall progress of lignification.

Detailed accounts of these studies will appear in due course in the *Archives of Biochemistry*.

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[2] Birkinshaw and Findlay, *Biochem. J.*, **34**, 82 (1940).
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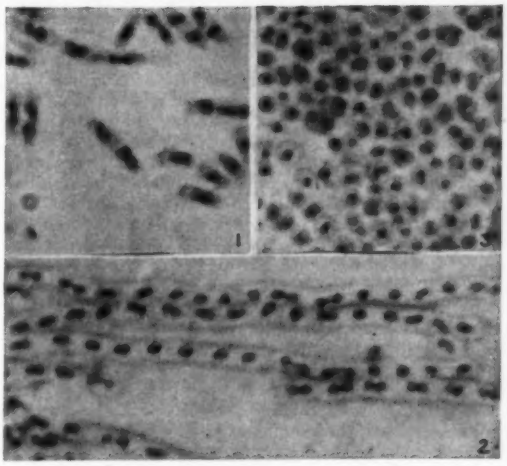
Demonstration of Bacterial Nuclei with Ribonuclease

As part of a general programme of research on the biological significance of nucleic acids in micro-organisms, we have investigated, under the direction of Prof. Boivin, the exact localization of ribo- and desoxyribo-nucleic acid in bacterial cells. Cytological observations of the last decade have furnished convincing evidence of discrete nuclei in many species of bacteria. A method that has been much used to differentiate the nuclear structures from the strongly basophilic cytoplasm consists in treating suitably fixed bacteria with warm hydrochloric acid, followed by staining with Giemsa solution[1]. Using chemical methods on bacteria in bulk, one of us demonstrated[2] that the success of the hydrochloric acid – Giemsa method is due to the fact that ribonucleic acid is removed more rapidly from the cells by hydrochloric acid than the desoxy compound. In view of this result, and of what is known about the distribution of the two types of nucleic acid in the cells of higher organisms, it is plausible to assume that in bacteria, too, ribonucleic acid is located in the cytoplasm, the desoxy acid in the nucleus, and that the high ribonucleic acid content of bacteria (10–15 per cent in cells from the end of the lag phase and the beginning of the logarithmic phase[3]) is responsible for the strongly basophilic character of young bacterial cells and the difficulties encountered in demonstrating their nuclei by conventional staining methods.

We have put this hypothesis to the test by studying the action of ribonuclease on bacteria[4]. By treating fixed bacteria with purified preparations of ribonuclease it is possible to suppress the affinity for basic dyes shown by the bacterial cell as a whole, leaving in its interior a chromophilic body which presents various aspects of constriction and division and is obviously the nucleus already seen by the earlier workers. (More recently, we have found that it is possible to suppress the affinity for basic dyes of not only the cytoplasm but also the nuclei by the successive action of ribo- and desoxy-ribonuclease.) The localization of ribonucleic acid in the bacterial cytoplasm is thus established, and the method gives, in addition, very convincing pictures of bacterial nuclei. The choice of the fixative proved very important in obtaining clear-cut results of enzyme action. Alcohol alone has given us poor results, formalin alone much better ones; in the end we decided in favour of Chabaud's[5] mixture of alcohol 80 per cent (60 ml.), phenol (15 gm.), formalin (5 ml.) and acetic acid (2 ml.), which has given consistently good results with a variety of materials. Osmium tetroxide, excellent as a fixative in connexion with the hydrochloric acid – Giemsa method, cannot be employed for preparations which are to be treated with ribonuclease, since osmium interferes with the action of the enzyme. The ribonuclease which we used was prepared from pancreas with slight modifications of the techniques of Kunitz and Dubos. Heating this preparation to 100° C. removes all traces of the heat-labile desoxy-ribonuclease but leaves the activity of the ribonuclease unimpaired.



Nuclei in *Bact. coli* (Fig. 1), *B. anthracis* (Fig. 2 and *N. gonorrhœæ* (Fig. 3) stained with Giemsa solution after pre-treatment with ribonuclease. Mag. × *c.* 3,000

To demonstrate nuclei, fixed films of bacteria were treated for several minutes with a 2 per cent solution of ribonuclease at 60° C., rinsed with water, stained with Giemsa solution and examined after drying.

Extraction with ribonuclease has enabled us to demonstrate nuclei in various stages of division very clearly in many different strains of *Bact. coli* (Fig. 1). In agreement with earlier workers we found single, central nuclei in some of the cells, regularly spaced groups and chains of nuclei in others. Very clear pictures of nuclei were also obtained after ribonuclease treatment of vegetative cells of *B. anthracis* (Fig. 2). In *C. diphtheriæ*, of which we examined a strain distinguished by the almost complete absence of metachromatic granulations, we met with a bewildering variety of nuclear configurations. We are now trying to ascertain whether any correlation exists between the different cytological appearances and the growth-cycle of this organism. We have also seen well-defined nuclei in enzyme-treated gonococci in pus and in pure culture preparations (Fig. 3). Pyogenic staphylococci proved very resistant towards ribonuclease and extraction with hydrochloric acid, although the chemical analyses carried out by one of us[2] show that staphylococci contain large amounts of the same ribo- and desoxy-ribonucleic acids that are found in other bacteria. To explain this unexpected result we must perhaps assume that in these organisms there exist special compounds of ribonucleic acid with the proteins of the cytoplasm, and that ribonuclease can only attack the free but not the bound nucleic acid. We are now experimenting with various pre-treatments (alkali, etc.) with the view of preparing resistant organisms for the action of ribonuclease, and have already obtained some encouraging results.

The best pictures of bacterial nuclei, regardless of whether ribonuclease or hydrochloric acid is used for their demonstration, are obtained with very young cultures, still in the lag phase or at the beginning of the logarithmic phase of growth. At this stage the cells are of maximal size; the nuclei, too, are very large but difficult to demonstrate without pre-treatment because the young cells are very rich in ribonucleic acid and hence intensely basophilic. By contrast, the cells of old cultures are far less strongly basophilic and their nuclei can often be stained directly without the help of any pre-treatment, a fact already utilized by Peshkoff[6]. A possible explanation of the changed staining properties of cells from old cultures may be simply the fact that many bacteria contain a very active ribonuclease, but lack appreciable amounts of desoxy-ribonuclease. For example, a ribonuclease from *Bact. coli*, which we have been able to extract and purify, has proved an entirely satisfactory substitute for pancreas ribonuclease in the demonstration of bacterial nuclei. Thus it may well be that in old cultures, where the majority of cells are dead, bacterial ribonuclease has destroyed the greater part of the ribonucleic acid in the dead cells, leaving the nucleus practically intact. However, this effect is not found in all bacteria, and there are great species variations in ribonuclease content. Thus, *B. anthracis* and the staphylococci contain much less ribonuclease than *Bact. coli*.

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[5] Chabaud, A., *Ann. Inst. Pasteur*, **68**, 106 (1942).
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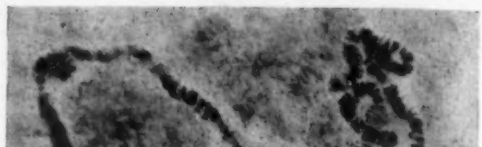
Salivary Gland Chromosomes of *Anopheles*

An investigation of the salivary gland chromosomes of *Anopheles maculipennis* var. *atroparvus* was begun with the aim of finding out: (1) whether a technique could be produced giving preparations of salivary gland chromosomes, of this and other species, sufficiently detailed for a proper cytological analysis; and (2) if this was possible, whether natural populations exhibit variation in the salivary gland chromosome patterns, and hence comparative karyology might supply an additional tool in the study of geographical, ecological and physiological variation in the genus *Anopheles*.

The first aim was successfully achieved after realizing that a main cause of past failure in obtaining good preparations lay in the conditions (especially nutritional) under which the larvæ were reared. The addition of certain growth factors in the medium proved decisive; the larvæ are now supplied with yeast and *Vorticellæ* in spring water corrected for salinity and *p*H (constant temperature 20–21° C.). The salivary gland chromosome preparations obtained after rearing the larvæ in this way are so clear that a 'map' for *Anopheles maculipennis* var. *atroparvus* has already been drawn. Encouraging results have also been obtained in the second aim, namely, that of variation in the salivary gland chromosome patterns in natural populations. In five instances differences have been found.



Photomicrograph of salivary gland chromosomes of *Anopheles maculipennis* var. *atroparvus*

Mitotic metaphase plates of *A. maculipennis* var. *atroparvus* show three pairs of chromosomes: two V-shaped and one, the sex chromosomes, rod-shaped. In the females the two rod-shaped chromosomes appear to be connected with two small heterochromatic dots. In the males the heterochromatic dot is smaller in one of the two sex chromosomes, which can therefore be assumed to be the *Y*-chromosome. It is interesting, in this connexion, that Stevens[1] found in *A. punctipennis* four pairs of chromosomes, one of which consisted of heterochromatic material.

The salivary glands of *A. maculipennis* var. *atroparvus* are divided into two lobes. There are about 65 cells in the distal lobe and 21 in the proximal one, the latter giving the best cytological preparations. The salivary gland cells show five chromosome elements connected by a chromocentre. The first of the two V-shaped chromosomes consists of a 'right' arm (II*D*) measuring 96 μ, and a 'left' arm (II*S*) measuring 102 μ; in both arms there are two well-defined zones easily recognizable, besides the two free ends. The second V-shaped chromosome consists of a 'right' arm (III*D*) measuring 116 μ and a 'left' arm (III*S*) measuring 78 μ; there are five easily recognizable zones, two in the III*D* and three in the III*S*, besides the two free ends. The sex chromosome measures 46 μ, and intercalary heterochromatic regions are probably present. This *X*-chromosome appears thicker and better defined in salivary glands of larvæ of females than in larvæ of males. The two heterochromatic dots present in the mitotic chromosomes cannot be identified in the salivary chromosomes.

The five chromosome elements have been carefully mapped, and such maps have made it possible to compare different races of *A. maculipennis*. The analysis of the salivary gland chromosomes of hybrid larvæ derived from crosses between different races could not be carried out during the winter, but is now in progress. Direct comparisons of the salivary gland patterns of *A. maculipennis* var. *atroparvus* with those of the varieties *elutus* and *tipicus* (from Rovigo Province) and *messeæ* (from Pavia Province), all having identical mitotic chromosomes and larval

and imaginal characters, show that: (1) *elutus* has two inversions, a small one in the *X*-chromosome and a larger one in the left arm of chromosome III; (2) *tipicus* has a large inversion in the right arm of chromosome III; (3) *messeæ* has a small translocation and a small inversion in the X-chromosome, and a large inversion in the right arm of chromosome III. All these arrangements are homozygous in each variety.

A comparative analysis is at present in progress with *A. bifurcatus*, the mitotic chromosomes (two V-shaped and one dot) of which differ from those of *maculipennis*. In the gangliar cells and in the resting stage of the germ cells of *bifurcatus* the heterochromatin is almost lacking. The salivary chromosomes of *bifurcatus* are different from those of *maculipennis*, though some similarity of pattern can be recognized in certain regions near the tips. It seems possible that the total or partial sterility of the inter-racial hybrids within the *maculipennis* species is correlated with the chromosomal rearrangements described here, and that the *bifurcatus* salivary chromosome pattern is derived from one similar to that now represented in *maculipennis*.

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[1] Stevens, *Biol. Bull.*, **20**, 109 (1910–11).

Histamine as a Physiological Activator of the Reticulo-Endothelial System

MY investigations since 1940 have led to the conclusion that histamine plays the decisive part in the phenomenon of phagocytosis. My experimental work has shown that histamine is able to transform resting endothelial cells into active phagocytes. It is histamine which, as the physiological activator, induces phagocytic activity of the whole reticulo-endothelial system.

If, for example, a histamine solution is painted on the skin of rats and Indian ink then injected into their blood, the smeared areas show grey spots; one can indeed 'write' with histamine on the skin. Through its influence the endothelial cells, especially in the small veins, are transformed to phagocytes and adsorb and accumulate the Indian ink just as reticulo-endothelial cells do. Injected histamine has a general 'activating' effect, for example, in mice, rats and guinea pigs, changing the endothelium of the small veins in all the striated muscles and in the wall of the duodenum into reticulo-endothelium.

This effect of histamine on the endothelial cells can be inhibited by: (1) increasing the tolerance of the animals to histamine, which in mice and rats is easily accomplished by daily repeated histamine injections (rising to 5–10 mgm. subcutaneous doses); (2) preliminary treatment with an anti-histamine agent, for example, Meier and Bucher's antistine[1] (2-(N-phenyl-N-benzyl-aminomethyl)-imidazolin), the specific effect of which is histamine-antagonism.

My experiments with this anti-histamine substance prove that the same characteristic activating effect of histamine keeps the actual reticulo-endothelial system in continuous activity. In the living animal the antistine vigorously curbs, or even stops, the phagocytic activity of the reticulo-endothelial cells. I have demonstrated the inhibiting effect by a new method, worked out with L. Szalay, for the continuous quantitative determination of the activity of the macrophage system.

We injected mice and rats intravenously with Indian jnk stabilized with gelatine, which circulates in the blood without a decrease in dispersion as long as the phagocytes accumulate it quantitatively. From a cut at the end of the tail we took 2–3 drops of blood every five minutes, absorbing it on filter paper so that it formed spots about 1 cm. in diameter. After drying, these pieces of filter paper were immersed in slightly alkaline water, in which the blood pigment dissolves, while the Indian ink remains adsorbed in the tissue of the paper. Thus we get a series of gradually paler black-grey homogeneous spots which clearly show the progressive elimination of the Indian ink. We determined the darkness of the Indian ink spots by objective photometric determination of the light reflected by the spot on to a rubidium photocell and measuring the photocurrent by means of a string electrometer. Thus we can calculate the percentage of the light reflected by the clean paper absorbed by the stained spots, and these numerical values represent precisely the process of Indian ink elimination. From data from animals pretreated with large doses of antistine, it appeared that the anti-histamine vigorously hindered, indeed temporarily almost entirely stopped, the Indian ink phagocytosis and greatly extended the elimination time.

That the cause of this inhibition by antistine is really a competitive antagonism between histamine and antistine in the reticulo-endothelial cells themselves was proved by experiments on surviving rat-livers, through which colloidal gold or Indian ink was perfused in 38° C. in Ringer–Locke solution containing 6 per cent human blood serum. While in the control experiments the Kupffer cells filled up in 50 minutes with the accumulated colloid, the antistine in 1 : 2,500 concentration so completely paralysed the phagocytes that they remained empty. The simultaneous addition of histamine to the same concentration, however, overcomes the antistine-inhibition and restores the Kupffer cells to their normal activity. I interpret these experiments as meaning that the two compounds of related structure compete on a mass action basis for one and the same receptor of the mesenchyme cell, the receptor to which histamine has to be bound to produce the phagocytic function. The reticulo-endothelial cells work under the constant influence of histamine, the place of origin of which is unknown.

My investigations indicate that, as the actual agent of phagocytosis, histamine—that is, its liberation—has a central role in the defensive and recuperative reactions of the organism. Its role in inflammation is primarily explained by its phagocyte-activating effect. The liberation of the latent histamine in the tissues through different physical and chemical influences is a purposeful process: in consequence of its effect the place of the lesion is immediately surrounded by an active reticulo-endothelial zone. Mechanical injury or substances causing inflammation, for example, allylisothiocyanate, also change the endothelium of the vessels into reticulo-endothelium. These indirect activating effects can also be inhibited by desensibilizing histamine treatment or by a previous antistine injection.

A detailed description of these investigations will be published elsewhere.

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May 12.

[1] Meier, R., and Bucher, K., *Schweiz. Med. Wochschr.*, **146**, 294.

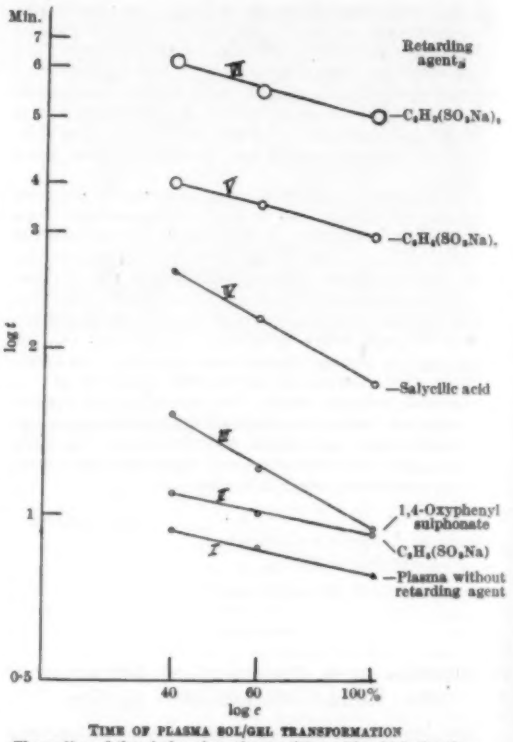
Influence of Hydrotropic Substances on the Sol/Gel Transformation of Blood Plasma *in vitro*

JORPES[1], studying the chemistry of heparin, and, before him, Demole[2] and Fischer[3], have insisted upon the importance of the $-SO_3H$ group for the inhibition of blood-clotting. Link *et al.*[4] have proved that salycilates have an antiprothrombinæmic effect, which is about twenty times weaker than the equivalent dose of 'Dicumarol' (Quick[5], McKennie[6]). In order to get comparable data between the retarding influence on blood-clotting and the chemical constitution, we have measured the effect of the following hydrotropic substances *in vitro*: the sodium salts of phenyl-sulphonic acid, 1,4-oxy-phenyl-sulphonic acid, salycilic acid, 1,3-phenyl-disulphonic acid, 1,3,5-phenyl-trisulphonic acid. The method consists in mixing in small test-tubes 0·1 ml. of normal oxalated blood-plasma (human) with 0·1 ml. of a mixture of phosphate buffer and hydrotropic substance, and 0·2 ml. 'Thromboplastin' (Hoffmann–LaRoche, Basle). The phosphate buffer consists of $M/30$ potassium dihydrogen phosphate and disodium hydrogen phosphate, so as to give a *p*H of 7·2. It contains, further, sufficient hydrotropic substance to make it one third molar.

Series of four test-tubes containing analogous mixtures are placed in a water-bath at 30° C. After two minutes 0·2 ml. of $M/40$ calcium chloride are added (time 0) and carefully mixed. Thus the volume of the final mixture is 0·6 ml. and the concentration of the retarding substance therein is $M/18$. The four test-tubes are then mechanically waved (not shaken) in the thermostat at 30° C., up to the time when the solution moves no longer as a liquid but becomes a firm gel. The moment when the sol/gel transformation is complete is sharply defined and takes place within 3–4 sec. for all the four test-tubes. In order to test the reproducibility, we have repeated the four-tube series three times. We found a variation of times within $\pm$ 1·5 sec. so long as the sol/gel transformation takes place in less than 2 min., and $\pm$ 2·5 sec. when the process takes longer. Besides the times for undiluted plasma we have also measured plasma-dilutions with saline of 60, 50 and 40 per cent. If we plot the logarithmic values of these dilutions (c) against the logarithmic values of the times (t) measured, the results give a straight line, the equation of which is

$$t = k \times c^{-a}$$ (compare Legler[7]).

The lowest line (I) is obtained without addition of a retarding substance. If we compare the time gained with undiluted plasma with the times retarded by addition of $C_6H_5SO_3Na$ (II), $C_6H_4(SO_3Na)_2$ (V) and $C_6H_3(SO_3Na)_3$ (VI), we find a proportion of 1 : 1·23 : 4·37 : 7·56. The retarding effect of two SO_3Na-groups instead of one is, therefore, 3·14, and the effect of three such groups instead of two is 3·19. The three sulphonates which were tested have a different parameter k but the same exponential factor a, as their lines have the same angle with the base



TIME OF PLASMA SOL/GEL TRANSFORMATION
The radius of the circles gives the precision with which the time of the plasma sol/gel transformation can be reproduced. With increased prolongation of the clotting process, the reproducibility tends to become less exact

line. It is noteworthy that both the lines of 1,4-oxyphenyl-sulphonate (III) and of salycilic acid (IV) have a different k and a from the three sulphonated products. The retarding effect of the five hydrotropic substances which were evaluated increases in the same order as the substances as listed above. Our results are a new proof that the more SO_3Na-groups are present in the molecule of an aromatic substance the more efficient they become in retarding the clotting process of blood plasma *in vitro*. Their action, insignificant *in vivo*, is ascribed to the very small molecular weight, compared with those of heparin and the different synthetic polysulphuric acid esters. Therefore, their concentration in the blood-stream is diminishing too rapidly.

The measurement of the sol/gel transformation time with 1,4-oxyphenylsulphonate as a retarding agent is of such precision that we have founded upon it a routine procedure for the clinical laboratory. Details of results are in the press and will be published elsewhere.

CH. WUNDERLY

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Cushion Cells in Retinal Pre-capillaries and Capillaries

I HAVE observed large cells of the intimal layer of retinal arterioles, capillaries and venules situated mostly at vessel branches. These cells reduce the lumen to a narrow slit or occlude it completely. The protoplasm of these cells is granular and gives them an appearance different from that of the other intimal cells. These cushion cells are best visible unstained in glycerine-cleared retina with reduced illumination.

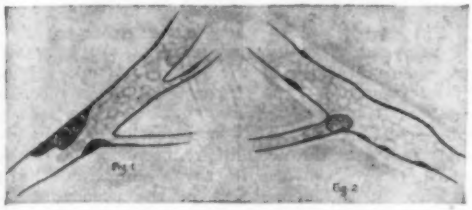

Fig. 1. CUSHION CELLS IN A RETINAL VENULE. UNSTAINED. × 225

Fig. 2. CUSHION CELL IN AN ARTERIAL BRANCH. UNSTAINED. × 225 RETINA IN BULK, CLEARED

They have been stained with azo-eosin in bulk. I was unable to discover them in stained paraffin sections. The dehydrating process seems to cause a shrinkage, which makes the cushion cells indistinguishable from other intimal cells. It is probable that these cushion cells regulate the retinal blood stream within the fine branches according to need.

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Unusual Flame Gases

HYDROGEN–AIR mixtures containing less than about 20 per cent hydrogen when burnt at an orifice undergo two highly contrasted modes of combustion which result in flame gases of very different types. In our experiments well-mixed mixtures of hydrogen and air contained in a tank were supplied to a burner in the form of a long narrow slit, the width of which was 1/16 in. The temperatures attained by very fine platinum–rhodium wires (0·0005 in. diameter) and by quartz-covered platinum wires (0·0005 in. overall diameter) were measured at some two hundred points in the flame gases. A contour map of the platinum wire temperatures in the lower portion of the flame gases resulting from the combustion of a 14 per cent mixture is shown in Fig. 1. These results are summarized in Fig. 2 and extended to a flame height twice that shown in Fig. 1. The temperatures measured by the quartz wire were almost exactly the same as those measured by the platinum wire, except in the early stages after combustion at the sides of the combustion zone (see dotted curves, Fig. 2).

From Fig. 2 it will be seen that after a prolonged interval (which decreases as the mixture strength is increased) the wire temperature attains a steady value, indicating that the flame gases have attained a state of equilibrium. The steady temperature is

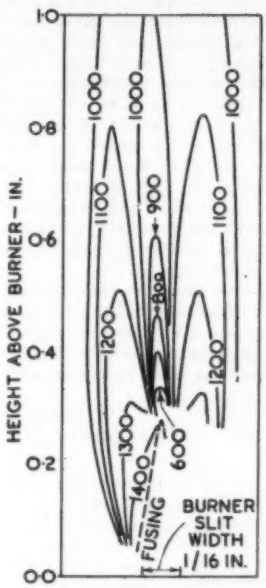

Fig. 1

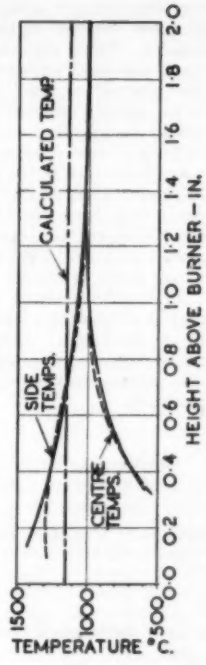

Fig. 2

some 130° C. below the calculated temperature (1,140° C.), and, as the radiation losses are known to be small, this suggests that the flame gases in this state contain in very stable fashion an unreleased energy[1,2] amounting to at least 10 per cent of the heat of combustion.

But we wish to direct attention especially to the state of the flame gases during the interval before the attainment of equilibrium. First take the central gases. It will be seen that immediately above the peak of the combustion zone the temperature measured by both the platinum and the quartz wires is less than 600° C. (which is more than 500° C. below the calculated temperature). This temperature gradually increases until the steady temperature of 1010° C. is reached. Flame photographs show that little, if any, luminosity (or ultra-violet radiation) is emitted by these gases, or indeed by the peak portion of the combustion zone from which they emerge. (We could only infer the position of the peak portion by the fusing of the platinum wire, as a result of surface combustion, as it was brought down into the unburnt gaseous mixture—see dotted curve, Fig. 1.) It seems possible that the cause of this curious type of combustion is a pre-treatment of the unburnt mixture during its travel upwards between the two intense side combustion zones (see below). The low temperature of the flame gases does not seem to be due to the formation of hydrogen peroxide, and we suggest tentatively that it may be due to temporary linkages of water molecules (as in the case of superheated steam near the saturation temperature).

In the case of the side flame gases, the platinum wire temperature is as much as 200° C. greater than the calculated temperature, and, very surprisingly,

the temperature attained by the quartz wire is just as great—except in the very early stages after combustion. These gases and the intense side combustion zones are readily photographed. If it may be assumed that atomic oxygen, unlike atomic hydrogen, combines equally efficiently on quartz as on platinum, it would seem clear that large quantities of atomic hydrogen are present in the flame gases as they leave the combustion zone, and that these react with oxygen to form atomic oxygen ($H + O_2 = OH + O$). Accepting this hypothesis, other experiments indicate that this reaction proceeds more slowly in flame gases at lower temperatures and more rapidly in flame gases at higher temperatures.

It is of interest to add that the wire temperature map is completely changed when some of the hydrogen in the hydrogen – air mixtures is replaced by carbon monoxide, and also when hydrogen is substituted for the excess oxygen present in the hydrogen – air mixture.

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[1] *Proc. Inst. Mech. Eng.*, 151, 236 (1944).
[2] *Nature*, 154, 115 (1944).

Second-Order Raman Spectra of Crystals

Using the smaller Hilger quartz spectrograph and the λ 2536·5 radiations of the mercury arc as exciter, tests were made to determine the minimum exposure times required to bring out the various features observed in a fully exposed Raman spectrum of diamond. The line with a frequency shift of 1332 cm.$^{-1}$ appeared on the plate with an exposure of only five seconds. Half a minute was needed to record the Brillouin doublet centred about the exciting radiation, the latter itself being filtered out by a mercury vapour screen. An exposure of half an hour sufficed to record the second-order Raman spectrum, while the anti-Stokes frequency shift of 1332 cm.$^{-1}$ appeared after forty-five minutes. An exposure of three hours results in heavily over-exposing the second-order Raman spectrum, but is useful in bringing out clearly the weak terminal line having a frequency shift 2015 cm.$^{-1}$, which is liable to be overlooked with smaller exposures. (This line and its more intense neighbour at 2176 cm.$^{-1}$ are of special interest as they appear with great intensity in the infra-red absorption spectrum of diamond.) Longer exposures up to ten hours reveal no new features. It is very significant that no hint or trace of the continuous spectrum of elastic vibrations forming the so-called 'acoustic branches' of the lattice spectrum of the crystal appears on the plate even with the longest exposures. This will be evident from a comparison of Fig. 1 (*a*) and 1 (*b*), the former being the spectrum of the mercury arc and the latter the spectrum of diamond recorded with six hours exposure.

The great disparity of behaviour which these observations disclose between the parts of the vibration spectrum in the upper and lower ranges of frequency is intelligible only when we recognize the fundamental difference in their nature. The acoustic spectrum has its origin in the propagation of elastic waves through the crystal from end to end, while

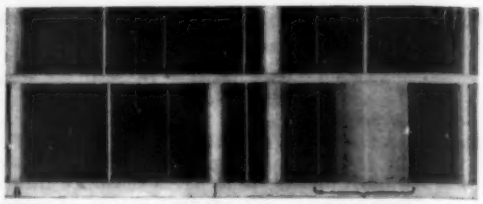

Fig. 1. Above, filtered mercury spectrum; below, heavily exposed Raman spectrum of diamond

the infra-red vibrations are evidently not 'waves' but eigen-vibrations of the individual units of the crystal structure. The experimental facts recorded here, and the discrete line structure of the second-order spectrum illustrated in an earlier communication[1] (see also the accompanying photomicrometer record (Fig. 2)), are in my opinion conclusive evidence of the correctness of the theory of the vibration spectra of crystals put forward by Sir C. V. Raman[2].

The alkali halides are much less suitable than diamond as material for investigations in this field, for their vibration frequencies are much lower and are also broadened out by thermal agitation; by reason of the ionic nature of the crystal, they also appear much more feebly in the second-order Raman effect. Hence the difficulty of obtaining adequately exposed and well-resolved spectrograms free from the effects of false illumination is far greater. Nevertheless, the results I have obtained with rock-salt[3] are clear enough and should convince those with practical experience of spectroscopic research in this field. The experimental difficulties in recording satisfactory results are even greater in the case of potassium chloride and potassium bromide than in the case of rock-salt, since the vibration frequencies are still lower. A comparison of the spectrogram of potassium chloride I have obtained[4] with that reproduced in a recent note in *Nature*[5] indicates that

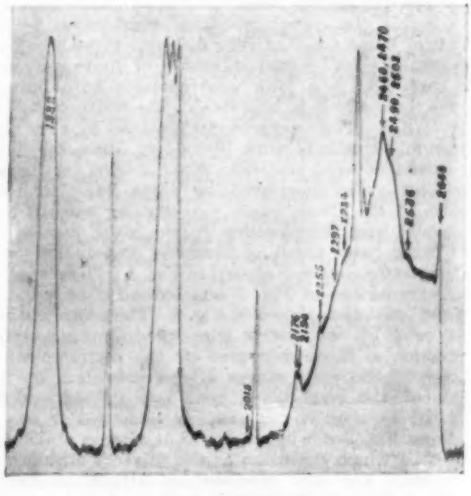

Fig. 2. Photomicrometric record of the Raman spectrum of diamond taken with medium-size spectrograph

the latter has been vitiated by parasitic illumination in the spectrograph.

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May 19.

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Adsorption Isotherm of a Photographic Emulsion for Uranyl and Lead Ions

RADIOACTIVE track count methods with photographic plates can be applied to the determination of nuclear reaction cross-sections, of nuclear particle fluxes, of decay constants and of small concentrations of certain elements[1]. The reactive nuclei can be introduced into the emulsion by the 'drop method', in which a drop of a suitable solution is spread on the surface of the emulsion, and left to penetrate into it, and to dry. This method uses the full quantity of the nuclei contained in the drop; however, the penetration into the emulsion is not uniform, so that an average track count must be derived from a survey of the whole area covered by the drop, or of a representative section of this area. In the alternative 'immersion method', the plate is left to imbibe the material from a solution in which the plate is totally immersed. Thus, the distribution of the dissolved substance over the emulsion must be uniform at least in the horizontal plane, but the fraction of the solute taken up by the emulsion depends on conditions and must be determined specially by conventional analytical or by radioactive methods. The uptake of uranium by Ilford Concentrated Half-Tone Plates and its dependence on time of immersion, conditions of rinsing after immersion, concentration of uranyl ion, *p*H and presence of other salts has been examined[1]. It seems desirable now to report the results of tests where the concentration was varied more widely, and where besides uranyl ions lead ions were employed.

The Ilford plates were handled as before[1], but the area of each field of view under the microscope was now only about 7×10^{-5} cm.^{2}. In Fig. 1 the uptake of uranium by the emulsion is plotted against time of immersion (in minutes) for four solutions of uranium in 5 per cent (by volume) acetic acid. The ordinates give the track counts (T) per field of view and 24 hours exposure,

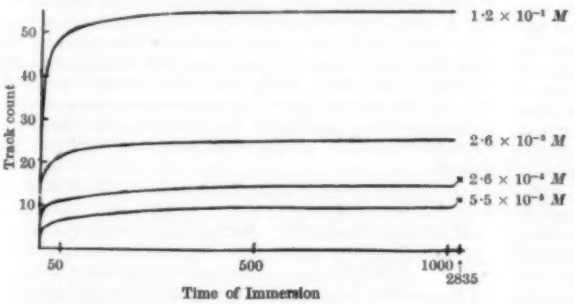

Fig. 1

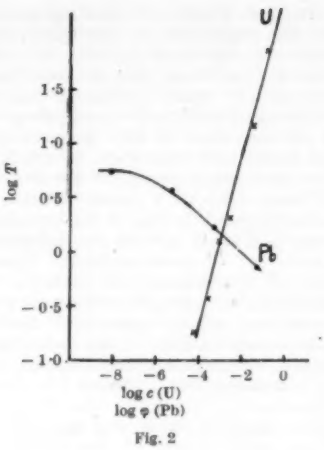

Fig. 2

and are multiplied by factors of 1, 12, 40 and 60. The rate of uptake decreases rapidly with time, and the shape of the curves at all concentrations is similar. In Fig. 2 (based on more experiments than Fig. 1) the track count per 24 hours exposure following immersion of standard duration (1,000 min.) is shown (logarithmically, for clarity) as a function of the concentration c. In spite of the lack of saturation and the blocking of part of the volume of the emulsion by silver salt, the absolute values of the uptake exceed the values calculated from the volume of the (dry) emulsion; for example, the track counts of the $1{\cdot}2 \times 10^{-1}$ and the $5{\cdot}5 \times 10^{-5}$ M solutions would correspond to $1{\cdot}1 \times 10^{-10}$ and $3{\cdot}5 \times 10^{-13}$ gram-atoms of uranium, respectively, in the cylindrical volume defined by one field of view (7×10^{-5} cm.^{2} area and the depth due to the thickness of the emulsion before fixing, namely, 2×10^{-3} cm.), and hence to concentrations in the emulsion of 0·78 and $2{\cdot}5 \times 10^{-3}$ M; these concentrations are larger than those in the solutions by factors of 6·5 and 45. The excess must be explained mainly through adsorption; the temporary expansion of the emulsion during impregnation through swelling is insufficient. Therefore, the uptake function of uranium (Fig. 2) can be described as an 'adsorption isotherm'. At saturation the adsorption isotherm will be of similar shape, as the ratio of the uptakes with different concentrations at 1,000 min. can scarcely differ from that at saturation (cf. Fig. 1). The uranium isotherm in Fig. 2 is well represented by a linear equation

$$\log T = \log A + f \log c,$$

with A as a numerical constant, and can be rewritten in the familiar form

$$T = Ac^f.$$

The exponent f has the value 0·80.

In tests with uranium the concentration cannot be decreased beyond certain limits if unreasonably long times of exposure are to be avoided. To cover a more extensive range of concentration some tests were carried out with the lead isotope thorium B, which can be diluted with inactive lead at will. In this way the radioactivity per unit volume of solution was kept constant, while the total concentration of

lead was changed. Thorium B itself emits only β-rays, which are not registered by the plate, but every disintegration is followed quickly by α-decay of either thorium C or C′, so that the total track count (thorium C and C′ tracks combined) still gives the number of decayed thorium B nuclei. Four thorium B solutions (of the order of 10^{-2} micro-curies/c.c.) in 5 per cent acetic acid were used, in which the total concentrations of lead were made $5{\cdot}3 \times 10^{-3}$, $5{\cdot}3 \times 10^{-4}$, $5{\cdot}3 \times 10^{-5}$ and $6{\cdot}8 \times 10^{-9}$ molar. The time of immersion was 30 min. In Fig. 2 the logarithm of the track count is plotted against the logarithm of the concentration (φ) of inactive lead. Here, in the evaluation of the adsorption isotherm from the graph, the 'invisible' adsorption of inactive lead must be taken account of by replacing T and c by $f_c T$ and φ. The concentration c of the radio-lead remains constant. At the higher concentrations the results fit again a straight line. Hence

$$\log T = \log B + g \log \varphi,$$

that is,

$$(f_c T) = B' \varphi^{g+1} = B' \varphi^{f}.$$

In the linear portion the value of f is 0·83, but at concentrations below about 10^{-6} the uptake increases more rapidly with concentration.

It will be interesting to compare by this sensitive method the adsorbability in standard conditions of chemically different α-active isotopes down to very small concentrations. From a practical point of view the knowledge of the adsorption isotherms will assist in the assay by track count methods of traces of α-ray emitters.

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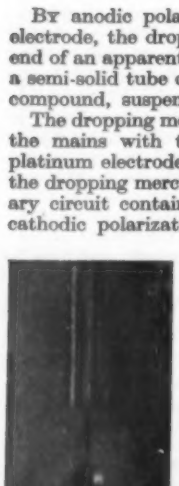
[1] Broda *J. Sci. Instr.*, **24**, 136 (1947).

Mercury Tube Effect

By anodic polarization of the dropping mercury electrode, the drops have been made to form at the end of an apparent 'mercury tube or thread', namely, a semi-solid tube or thread of mercury, or a mercury compound, suspended from the capillary tube.

The dropping mercury electrode was polarized from the mains with the aid of a potential divider. A platinum electrode functioned as an anode, both for the dropping mercury electrode and in a supplementary circuit containing a 2-volt accumulator for the cathodic polarization of a layer of mercury at the bottom of the cell (used in the purification of the solution by pre-polarization). The dropping mercury electrode was first polarized cathodically at a current-strength of 10^{-1} amp. At this current bubbles were generated at the end of the tip and dropping ceased. The applied potential was now decreased to zero, thus connecting the dropping mercury electrode with the platinum anode and anodically polarizing it with respect to the cathodic mercury pool at the bottom of the cell. A few seconds after the commencement of anodic polarization, darkened drops appeared, which, upon falling from the capillary, left behind them a black tube. After the formation of the tube, the drops grew at its end and fell therefrom, largely as if from the capillary. In some experiments, after an indefinite time from the commencement of formation of the tube, a sudden extension in its length took place; this seemed to occur when the drop size was at its maximum. The potential of the dropping mercury electrode was about + 1·7 volts on the hydrogen scale at the commencement of the phenomenon, and seemed generally to fall to a potential between about + 0·8 and + 1·3 volts when the phenomenon ceased.



The black thread was collected in a cup operated from outside the cell. The collected substance appeared to decompose rapidly to mercury when removed from the solution, thus making its analysis difficult.

It seems probable that the anodic evolution of chlorine at the electrode in the above experiment forms a thin film of a chloride of mercury and that it is an elongated skin of this which forms the tube. It is possible that the sudden increase in length of the tube sometimes observed is due to the completion of a layer of a different chloride formed during the continued anodic polarization.

An investigation of the phenomenon is in progress.

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Spiral Cracks in Glass Tubing

To the examples cited by Dr. J. J. Hopfield and Messrs. B. N. Clack and N. L. Harris on this subject, I should like to add a further rather unusual example. This was in *X*8 soda-glass tubing of 6–7 mm. diameter and 0·15–0·25 mm. wall-thickness. Large quantities of this tubing were being handled, and frequently, when it was being cut into lengths, a spiral or rather helical crack would fly along the piece. The cracks were of 5–7 mm. pitch, and produced springy lengths of up to 12 in.

With such a thin wall the strain 'through the wall', which caused such cracks as those previously cited, would scarcely at first sight be expected. However, the tubing was being produced by machine-drawing at a very high rate, some 1,000 ft. per minute, so that the rush through the air and the resulting rapid cooling of the outer skin, while the inner was kept hot by the hot air-blast through the mandrel, could very well have produced this strain. In the very thin section this strain was naturally difficult to detect.

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[1] *Nature*, **158**, 582 (1946): **159**, 541 (1947).

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

THE manifold demands made by a live industry on its research association are well illustrated by some of the current activities of the British Iron and Steel Research Association. Co-operative research lends itself readily to organised investigation into the background problems of industrial processes. Sometimes these are indicated by the failure of an unproved technique; sometimes by new demands on the part of the user which call for extension of knowledge and technique on the part of the supplying industry; but most often the process is dictated by the natural desire of the industry concerned to improve its processes, qualities and general economy.

An example of investigations stimulated by the failure of a technique insufficiently understood is the work which has been done on brittle fracture in mild steel plates. The welding in certain ships made in foreign countries during the War failed, and representatives of all British organisations interested—governmental and Service departments, other research associations, the universities, Lloyd's and numerous industrial laboratories—carried out various investigations culminating in a conference in October 1945. As a result of intensive discussion under the chairmanship of Dr. (now Sir Andrew) McCance, who is chairman of the council of the British Iron and Steel Research Association, the lines of research necessary for ascertaining the cause and cure of the phenomenon of brittle fracture were indicated.

Subsequent researches at the works of Colvilles Ltd., and at the University of Cambridge, established that brittle fracture was related to manganese content, plate thickness and the rate of cooling, the effect of the first factor being by far the greatest. Further work at Colvilles on small, closely controlled casts of steel made by the high-frequency process has now established that for a given tensile strength an increase in the manganese – carbon ratio of mild steel has the desired effect of lowering the temperature range below which one must go before brittle fracture may take place. This effect is related to the fact that the increased ratio also tends to give a fine-grain steel. The latest work on this subject is able to conclude with a practical recommendation that for shipbuilding steels the manganese – carbon ratio should not be less than 3·0.

The results to date of this extensive series of experiments have been distributed to the members of the Association and participants in the original conference, and are shortly to be made available to a wider public through the technical press.

Another project also bears on embrittlement, but in this case at high temperatures. The brittle constituent (sigma phase) of the iron – chromium and the iron–chromium–nickel systems is being studied at the National Physical Laboratory for the Association, as the appearance of this constituent during service at elevated temperatures can cause serious embrittlement in certain commercial alloys. Limits in composition to avoid the appearance of the sigma phase are now being defined for pure ternary alloys, and eventually the effect of other elements upon the systems will be investigated. A related and rather more extensive research deals with the influence of alloying elements on the properties of ferrite.

These latter projects may be taken as examples of investigations with the object of meeting new demands, in this case made by the designers of gas turbines and other high-duty engines. The successes met with by the works laboratories, working in competition, are well known, and may be said to be approaching their limits within the bounds of the available 'background' knowledge. It is the natural task of the research association to organise the pooling of information to the necessary extent, and to widen our background knowledge, thus enabling the industrial laboratories to proceed once more in healthy rivalry. This is a continuing process, which an alert industry will demand of its research association without intermission.

The great bulk of the work of the British Iron and Steel Research Association, however, originates from the discussions of the voluntary panels and committees which supervise and canalize the Association's activities. These committees are widely drawn from the iron and steel industry, the universities of Great Britain, Government research laboratories, steel users, etc. They are kept small, the total membership numbering about 450 for nearly sixty committees. The Association's work is organised in six divisions, corresponding to the main divisions in the industry, each being controlled on a largely decentralized basis by a panel. There are also three, so to speak, 'horizontal' departments (physics, chemistry and engineering) which carry out more fundamental work and work common to a number of divisions, and incidentally play a useful part in maintaining liaison between the six divisions.

Some three hundred projects are in hand, covering the industry's production cycle from the blast furnace and its raw materials to the rolling mill, draw-bench and final application. These projects range from the severely practical to the 'purely' theoretical.

The modern blast furnace is highly efficient from a thermal point of view. Improvement is sought, however, in output, smooth working, high-grade production, requirements of special coke and in general operational economy. A considerable volume of work goes on in attempts to determine the best conditions and proportions of the constituents of the burden, the best methods of distribution and the extent of heat and gas penetration into various types and sizes of ore. Consideration is also being given to the use of gas turbines for blowing. The Association has an experimental blast furnace with a 1 ft. 9 in. hearth at Stoke-on-Trent where much of this work is carried out. This 'baby' is believed to be the smallest working blast furnace in existence.

At Stoke-on-Trent the Association has in addition a model open-hearth furnace, which for the last two years has afforded information of great importance on the design and operation of such furnaces. Also at the steel-making stage the factors affecting sulphur removal are being studied both in the plant and in the laboratory. Most of the latter work is done at the universities. The subjects of instrumentation and heat measurement receive their share of attention, and the new problems raised in the extensive programme of converting open-hearth furnaces to oil firing lend particular importance to these investigations. The Physics Department has constructed a black-body furnace with a 3-in. aperture for calibrating pyrometers up to 1,700° C., and is also investigating problems in connexion with quick immersion thermocouples.

It is part of the task of the Chemistry Department to work in close collaboration with the British Refractories Research Association, and one of the

big problems in this field is at present the development of the all-basic open-hearth furnace. This should have many advantages over the normal type with a silica roof, and its higher operating temperature should result in increased output.

In the field of steel castings, a thorough investigation is being made into foundry moulding materials and the fundamental mechanism whereby they are bonded together. The allied problems of hot tearing and the rate and direction of heat abstraction on solidification are being examined, as also are methods of controlling the melting process by spectroscopic inspection of the flame of Tropenas converters during steel-melting.

Work going forward nearer the finishing end of the industry includes research on coating, rolling and drawing. At the Association's new laboratories in South Wales (see *Nature*, July 19, p. 100), work goes on concerned with the distribution, thickness and porosity of tin, zinc and non-metallic coatings, and with further projects on the geometrical characteristics of metal surfaces.

In the investigations into drawing problems, the Physics Department has assisted in devising an instrument for measuring the tension in wire as it is drawn, the variations in oscillation under varying tensions being used for this purpose. Theoretical and practical work on plastic deformation in rolling goes forward at the Universities of Cambridge and Sheffield.

The engineering problems that face the iron and steel industry are sometimes insufficiently regarded as being suitable objects of scientific approach. Here the Association's Plant Engineering Division has a wide field, and has done much useful work in organising conferences and other means of exchanging knowledge—a function of immediate importance in the industry's modernization plans. This Division also methodically studies steel-works transport, design and operation problems, and is responsible for a wide range of research on fuel problems.

This very brief summary suffices to show the immensely wide field an industrial research association has to cover. The work ranges from the most 'purely' theoretical study of the thermodynamic and chemical aspects of the steel-making process, to the most severely practical investigation into engineering problems. All this is comprehended in the mutual aim of science and industry to ensure that the methods and discoveries of the one shall be with the least delay at the service of the other.

BOTANY OF THE WILD AND CULTIVATED RICES

By Dr. D. CHATTERJEE
The Herbarium, Royal Botanic Gardens, Kew

ALTHOUGH much work has been done on the widely cultivated species of rice (*Oryza sativa* Linn.) for its improvement as an agricultural crop, it must be admitted that our knowledge of its morphology and taxonomy and its relationship to other wild species of the genus is comparatively meagre. The term 'wild rice' as employed here is used to indicate all other species which conform by their technical characters to the generic definition of *Oryza*, and which grow spontaneously in a wild state. The two cultivated species are the well-known *Oryza sativa* Linn. and the less known *Oryza glaberrima* Steud. (cultivated in west tropical Africa). In tropical countries where these species are extensively cultivated, it is unfortunate that a comprehensive account of the rice plant with a proper interpretation of all the structures, its evolution and domestication by man is not generally given in text-books on botany and tropical agriculture. This omission makes its study uninteresting and often vague. The aim of this note is to put together some of these much-needed data with a suitable list for further reference.

Domestication of 'Wild Rice' by Man

The history of cultivated rice goes so far back into the distant past that it could be associated with the early history of man. It has been said that man has passed through three successive stages of civilization, that is, the hunting, pastoral, and agricultural. In the early stage men hunted in packs the wild animals of the grassland. The women also hunted with the men and equally shared the products of the chase. The cares of maternity and increased attachment to their homes often made it necessary for the women to drop out from the band for a time. Gradually women found it necessary to supplement their diet with nuts, berries and grains of grasses at times when the food supplies brought by their men-folk ran out. Homes were established near the seashore and banks of lakes and rivers. Fishes and molluscs were also gathered from these sources to supplement the food. Domestication of cattle began at this stage of pastoral life. The idea of growing grains of wild grasses by actual cultivation of land came later, and the exact circumstances are not known but are subject to various speculations.

Recent discoveries in India at Mohenjo-daro in Sind and at Harappa in the Punjab have shown that civilization entered the country as early as 3000–2500 B.C. It appears that the people who came to the Indus Valley at that time from the west had a knowledge of wheat cultivation and they readily adopted the wild rice which they found in that part of India. There is also reason for believing that the people of Mohenjo-daro had trade relations with the Sumerian cities of Mesopotamia, and both wheat and rice might have constituted the articles for trade. Between 400–300 B.C. rice was cultivated beyond the western limits of India and later it was grown in Babylonia, Bacterina and lower Syria. During the early period of the Christian era cultivation was started in Persia and Egypt. In China and Indo-China rice was in cultivation for a long time and no definite account is available how these countries received the art of rice cultivation from the Indus Valley. A possible suggestion is by way of the Hindu Kush, Tibet and Mongolia. The cultivation has spread to Malaysia, Africa and America in recent years. Knowledge of rice cultivation came to south-eastern Europe through the Arabs, who also introduced its cultivation in Spain after their conquest of that country.

The wild rice of India, which may be regarded as the ancestor of the cultivated rice, is found throughout India, Burma and Malaysia. It resembles the ordinary cultivated rice very much but has deciduous spikelets, 3–10 cm. long awns, and a dark red spot between the apex of the *lemma* and the awn. Having taken this plant into domestication, early man, consciously or unconsciously, effected a general trend of improvement by selecting those plants which possessed certain desirable and stable characteristics. These might have been: (1) tufted growth and pro-

duction of tillers, (2) a height of 3–4 ft., (3) suitability of living in still and shallow water, (4) production at the end of about six months of starchy grains which are not shed, and (5) when the husked grains are boiled they give a pleasant appearance and do not adhere to each other. From this theoretical line, it must be admitted that variations due to mutation and hybridization must have taken place which have given rise to the several hundreds of forms and varieties. The main important change, introduced by domestication, to the wild rice is the loss of its power to shed the mature spikelets. The power to shed the mature grains is an essential character connected with the dispersal of the seed and ensuring the continuity of the species in all wild plants. This loss of power to shed grains has indeed been a gain on the part of the cultivator; he can now get all the spikelets for the use of mankind from his crop without the fear of losing a large quantity on the field.

Botanists like Chevalier[1] and Backer[2] have considered that the name of this wild rice should be *Oryza fatua* Koen. This name was also followed by Burkill[3] in his discussion of the origin of the cultivated rice. Unfortunately, for technical reasons this name could not be accepted, as this was not validly published with a suitable specific description (*Mem. Acad. Sc. Petersb.*, Ser. 6, 5, pt. 2, 177; 1840). The same plant was described by Prain[4] under the name *Oryza sativa* Linn. var. *fatua* Prain, and this name may be provisionally retained to designate the wild rice of south-east Asia. It is preferable that the wild rice should be separated specifically from the cultivated species of *O. sativa* Linn., since this will be more convenient from the point of view of agricultural workers and other practical considerations. The varietal name given by Prain has to be given up when the specific name of this wild rice is determined by a monographer of the genus. The choice will probably depend on one of the three names *O. montana* Lour. (1790), *O. aristata* Blanco (1837), and *O. rufipogon* Griffith (1851). The type sheets of none of these species are available to me, and so I have left the point undecided and provisionally accepted Prain's varietal name. A good description of this wild rice is given by Bor[17], Backer[2] (under *O. fatua* Koen.) and Watt[10] (under *O. sativa* Linn. var. *bengalensis* Watt).

The cultivated rice *O. sativa* Linn. embraces wide variations in forms, and in all probability it is a composite species of polyphyletic origin. Griffith says, "It has always appeared to me that the union of all the different kinds of rice into one *O. sativa* Linn. was arbitrary. Roschevicz[4] says, "Our cultivated rice is of polyphyletic origin and that its different groups and varieties may have arisen from different species of wild rice belonging to the section *Sativa* Roschev., or from hybrids between the wild rices of this section and cultivated ones". Roschevicz also admits that *O. sativa* Linn. represents in all probability a complex of small independent species.

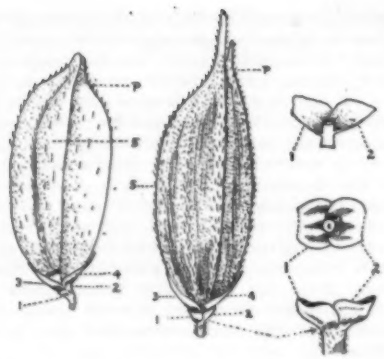
In Africa, some varieties of a cultivated rice approach *O. breviligulata* A. Chev. et Roehr. by the characters of ligule, the thickness of panicle, the strong thick awn, and Chevalier[1] rightly thinks that this wild species should be regarded as the ancestor of *O. glaberrima* Steud. which is largely cultivated in west tropical Africa along with *O. sativa* Linn.

The Rice Spikelet

The development of a large number of spikelets in the panicle is no doubt the primary cause of the reduction of some of the floral and extra-floral parts which has made the morphology of the rice spikelet a subject of special interest to botanists. The commonly known interpretation which is also found in some of the text-books is that the rice spikelet has four scales, of which the lower two are considered as non-flowering and the third large boat-shaped structure as the flowering scale (or lemma). In the axil of the lemma and between it and a similar structure, the palea, the flower is borne. There are two other very minute and extremely reduced scales at the tip of the pedicel which have been treated by many botanists as mere outgrowths. But the fact that these are constantly present and often distinct and better developed in some species shows that these are significant structures and have to be interpreted.

In 1900, Stapf[5] suggested that the rice spikelet theoretically or normally consists of six scales, of which the two lowest are very minute and more or less confluent with the tip of the pedicel and rarely discernible except with the use of a high-powered lens. The spikelet is therefore only apparently articulate with the pedicel, the real articulation being above these two rudimentary glumes. The two following structures, also empty, are usually small and one or rarely both are sometimes suppressed. The next one is the flowering scale (fertile lemma) and the uppermost the palea. The palea is very anomalous, being three-nerved and as coriaceous as the fertile lemma. In 1908, Cooke[7] arrived at the same interpretation and described the spikelet of the genus *Oryza* as having six scale-like structures. In his description of *O. coarctata* Roxb. he referred to the lowest pair of these scales as "two opposite minute appressed rounded or truncate thick scales, one attached lower than the other". Later Graham[8] made a particular study of the upper end of the pedicel of rice spikelet, and concluded that the enlargement at the tip is generally annular and in many varieties this structure becomes scale-like. Both Cooke and Graham admitted the presence of two scaly structures at the tip of the pedicel. These scales, although somewhat reduced in *O. sativa* Linn., are better developed in *O. ridleyi* Hook.f., while they are relatively large, clearly defined and well developed in *O. australiensis* Domin.

Other supporters of Stapf's view are Arber[9], Hubbard[10] and Michaud[11]. Arber made serial sections through a young rice spikelet which convinced her that the apical outgrowth at the tip of the pedicel really represented two outer glumes in an extremely reduced form. Hubbard, in his discussion, confirmed Stapf's interpretation, and also showed with a very ably executed drawing that this particular pair of glumes was exceptionally well developed as two distinct semi-oblate structures. Lastly, Michaud's discovery of abnormal florets in the axils of the pair of scales commonly considered as non-flowering indicates that these should be considered as flowering scales (or lemmas), although they are usually sterile. This naturally suggests that the spikelet of rice is theoretically three-flowered and consists of six scales and one flower as stated by Stapf. This view may be regarded as the best interpretation of the rice spikelet and is shown in Fig. 1. The lowest pair of scales should be considered as the glumes (true), the next pair of scales as sterile lemmas and lastly the fertile lemma enclosing a flower between it and the usual coriaceous palea.



O. sativa Linn. *O. australiensis* Domin
1, 2, glumes; 3, 4, sterile lemmas; 5, fertile lemma; *P*, palea.

Fig. 1

Stapf arrived at his interpretation of the rice spikelet only after careful examination of considerable herbarium and fresh material. His supporters, too, examined the spikelet from different points of view and came to the same conclusion. The present writer has also examined all the species of *Oryza* and agrees with Stapf and others. But Backer[9] has recently opposed this interpretation, and pleaded for a reversion to the older theory of regarding the lower pair of scales as mere cupular outgrowths of the pedicel tip and the sterile lemmas as the glumes. It is not known whether he examined the materials of species like *O. australiensis* Domin and *O. ridleyi* Hook.f. or whether he consulted the publications of Arber, Hubbard and Michaud (loc. cit.). In any event, he did not say so in his discussion. Backer has also erred in describing Stapf's view as merely theoretical, whereas his own might equally well be so described, since he compares the pedicel tip of *Oryza* with true examples of cupular structures from *Asthenochloa*, a genus belonging to a very different and distinct tribe of grasses. An examination of the spikelet of *O. australiensis* Domin would show quite clearly that these two scales are placed one *above* the other and not in the form of a cup, as is commonly imagined, and as is found in *Asthenochloa*.

Peterson[12] and Parodi[13] independently advanced a somewhat different view on the structure of the rice spikelet. Their views involve certain bold assumptions with which I cannot agree. According to them the rice spikelet essentially represents the union of two florets, in which the paleas of both and the pistil of one have disappeared. The two large scales enclosing the flower are then considered as two fertile lemmas. If we accept their view that the so-called palea is really a lemma of the theoretical second flower, then in a serial section this would appear after the point of insertion of the first flower is well passed. But Rossberg[14] has shown that this is not the case and that the so-called palea appears to originate beneath the first flower. This reduces the second fertile lemma of Peterson and Parodi to the status of a palea. The present writer has no doubt that this structure is truly a palea, as in a mature caryopsis the hilum points towards it. Incidentally, Rossberg has also tried to explain the unusual three-nerved palea of rice. According to him the palea evolves in a grass spikelet by the intergrowth of two originally separate leaves or leaf-primordia. These primordia have one or two nerves each and we get a two- or four-nerved palea by their lateral fusion. It has been reasonably suggested that the three-nerved palea is derived from a four-nerved one by the union or coalition of the two inner nerves or by the replacement of the inner two by a single nerve.

The Genus *Oryza*

The genus *Oryza* belongs to the Oryzeæ tribe of grasses. This tribe is characterized in having plants which are usually hygrophilous or aquatic and having small similar or dissimilar one–three-flowered spikelets, reduced scale-like sterile lemmas and minute glumes below, disarticulating rachilla, three–nine-nerved lemma and palea and usually six (rarely three, two or one) stamens. In the old world, genera like *Leersia*, *Potamophila*, *Oryza* and *Hygroryza* are well developed, while in America these are counterbalanced by the development of genera like *Luziola*, *Zizaniopsis* and *Hydrochloa*. The genus *Lygeum*, which was originally considered to belong to the tribe Oryzeæ, has now been separated out on account of its characteristic chromosomes. Genera like *Anomochloa* and *Reynaudia* are also now excluded from this tribe for other obvious reasons. The tribe Oryzeæ is subdivided into two groups, Oryzineæ and Zizanineæ, on the basis of hermaphrodite and unisexual flowers. A general account of these genera with suitable keys has been given by Prodoehl[15] and Bews[16]. The genus *Oryza* is undoubtedly the most important in the tribe and should be re-defined along the lines of Stapf's view discussed above. It consists of twenty-three species distributed in the warmer parts of Asia, Africa, Australia and America. Fig. 2 shows the general distribution of the species.

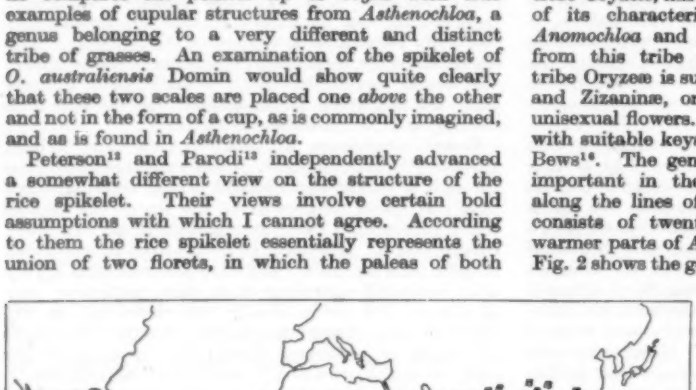


Fig. 2. Distribution of wild and cultivated rices

The species which I accept as good species and are referred to in the map are as follows: 1, *O. alta* Swallen; 2, *O. australiensis* Domin; 3, *O. brachyantha* A. Cheval. et Roehr.; 4, *O. breviligulata* A. Cheval. et Roehr.; 5, *O. coarctata* Roxb.; 6, *O. eichingeri* Peter; 7, *O. glaberrima* Steud.; 8, *O. grandiglumis* (Doell) Prodoehl; 9, *O. granulata* Nees et Arn. ex Hook.f.; 10, *O. latifolia* Desv.; 11, *O. meyeriana* (Zoll. et Mor.) Baill.; 12, *O. minuta* Presl; 13, *O. officinalis* Wall. ex Watt; 14, *O. perennis* Moench; 15, *O.*

Fig. 3
O. ridleyi Hook.f.

perrieri A. Camus; 16, *O. punctata* Kotschy; 17, *O. ridleyi* Hook.f. (Fig. 3); 18, *O. sativa* Linn.; 19, *O. sativa* Linn. var. *fatua* Prain; 20, *O. schlechteri* Pilger; 21, *O. stapfii* Roschev.; 22, *O. subulata* Nees; 23, *O. tisseranti* A. Cheval.

The cultivated area of *O. sativa* Linn. is not shown in the map. It is cultivated throughout south-east Asia, China, New Guinea, Persia, Egypt, east, central, and west tropical Africa, Italy, Spain, and Central and South America.

A fuller account, with a key to the species and their synonymy, will be published elsewhere.

I am indebted to Dr. S. D. Chaudhury, Economic Botanist, Assam, for directing my attention to the subject, and also to my colleague, Mr. C. E. Hubbard, for valuable help in the preparation of this article.

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ANIMAL DISEASES AND HUMAN WELFARE

IN March, 1946, the Section of Biology of the New York Academy of Sciences held a conference on the "Relation of Diseases of the Lower Animals to Human Welfare", and the nine papers read before this conference have been published in the *Annals* of the Academy (**48**, Art. 6, pp. 351–576; 1947). These papers, each of which is contributed by an expert, deal with rabies, equine encephalomyelitis, psittacosis and diseases related to it, brucellosis, plague, tuberculosis, anthrax, swine erysipelas and various animal parasites transmissible to man. In his introductory address, W. A. Hagan points out that the authors of the various papers consider primarily diseases of animals which are more or less directly transmissible to man, but that these diseases also affect the welfare of mankind by their economic effects. Obviously, for example, they affect our food supplies and, in addition, many people depend for their livelihood upon the rearing of farm animals.

The statistics given by Hagan of the losses inflicted by disease upon farm animals in the United States certainly bring home to us, especially just now when world food supplies are so difficult, the very great importance of the study of animal diseases. Nearly half the pigs born in the United States die before they reach marketable age. To this loss must be added the loss of the grain fed to them and also the increased cost of the products derived from the pigs which do survive. About a quarter of the 'adult chickens' die from disease each year in the United States, and one cow out of every four or five contracts inflammation of the udder (mastitis), with a consequent serious reduction of the milk supply and an increase in its price. The total losses from animal diseases in the United States are, Mr. Hagan thinks, probably smaller than they are in any other major country. Rightly he calculates not only the losses due to actual deaths, which represent only a fraction of the total loss, but also the effects of various kinds of parasitic animals which reduce the vitality of farm stock and render them more liable to diseases caused by other agents. As Mr. Hagan puts it, losses due to morbidity are much greater than those due to mortality.

A table of losses in 1942 due to various causes, which was compiled by the United States Bureau of Animal Industry, places the total losses due to parasitic animals alone at 290 million dollars, which is 69 per cent of the total animal loss of 418 million dollars. Chronic infectious diseases accounted for a loss of 70 million dollars. Acute fatal diseases, on the other hand, caused only 15 per cent of the total loss, and more than three quarters of this amount was due to a single disease—hog cholera. These figures, startling as they are, are considered by Mr. Hagan to be far too low. He would place the total annual loss at more than a thousand million dollars.

There is, however, a brighter side to this grave picture. The table given also shows that some of the great scourges of farm stock in other countries have been eliminated, or nearly eliminated, from the United States. Tuberculosis of cattle, for example, which is still a serious scourge of Britain and other countries, has been almost eradicated from the United States; and rinderpest, foot-and-mouth disease, bovine piroplasmosis and contagious pleuro-pneumonia have also been wiped out.

These are great achievements. Their value in terms of the relief of animal suffering is incalculable. Their economic value to man can be gauged by reference to the figures given above. Nor must we forget that many of the major diseases of farm stock are communicable to man, tuberculosis being in the forefront of these. It would seem, indeed, that, if the achievements recorded in this series of papers could be repeated in all the great food-producing countries of the world, the present urgent problem of the world's food-supplies would either disappear or would be very much less difficult to solve. How much is being done in various countries is evident in the articles which appear in this important publication. Unhappily evident also, however, is the gravity of the menace of the diseases which still remain to be overcome. The conquest of these may take time; but it cannot long resist the kind of spirit and effort which veterinarians all over the world, and the medical men who work with them, are contributing to the international service of mankind. G. LAPAGE

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SPEECH THERAPIST—The County Medical Officer, County Hall, Hertford (August 23).

UNIVERSITY FELLOWSHIP IN ENGINEERING, UNIVERSITY POST-GRADUATE STUDENTSHIPS (*a*) Kitchener (Engineering), (*b*) David Rew (Electrical Engineering), (*c*) Joseph and Lucy Chadwick (Engineering), —The Registrar, The University, Liverpool (August 23).

ASSISTANT PROFESSOR OF MINING, and an ASSISTANT PROFESSOR OF GEOLOGY, at the Faculty of Engineering, Fouad I University, Giza, Egypt—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (August 31).

SENIOR LECTURESHIP IN ACCOUNTING at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 31).

PROFESSOR OF OCEANOGRAPHY (biological, physical, or both) in Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (August 31).

EDWARD A. DEEDS FELLOWSHIP in University College, Dundee, for research in Physical Science, viz., Engineering, Metallurgy, Chemistry, Physics, Mathematical Physics, or any cognate subject—The Secretary, University College, Dundee (August 31).

DEMONSTRATOR IN BOTANY—The Registrar, Wye College, Wye, Kent (September 1).

READERSHIP IN COLONIAL ADMINISTRATION tenable at the London School of Economics—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 4).

ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, University College, Hull (September 6).

TECHNICIAN IN THE ANATOMY DEPARTMENT—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1 (September 6).

LECTURER (Grade I) IN THE PHYSIOLOGICAL DEPARTMENT (Lecturer in Histology)—The Secretary, The University, Edmund Street, Birmingham 3 (September 6).

LECTURER or an ASSISTANT LECTURER (Grade II or III) IN BOTANY —The Secretary and Registrar, The University, Bristol (September 10).

SENIOR PRINCIPAL SCIENTIFIC OFFICER or PRINCIPAL SCIENTIFIC OFFICER in the Armament Research Department of the Ministry of Supply in London—The Secretary, Civil Service Commission, Scientific Adviser's Branch, 27 Grosvenor Square, London, W.1, quoting No. 1961 (September 18).

LECTURER IN ANATOMY, preferably with some experience in Histology—The Secretary, The University, Aberdeen (September 18).

VICE-CHANCELLOR, and a SENIOR LECTURER IN GEOLOGY, at the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 30).

PROFESSOR OF CELTIC LANGUAGES AND LITERATURE—The Secretary, Queen's University, Belfast (September 30).

SENIOR PLANT BREEDER and a SENIOR PLANT PHYSIOLOGIST under a Cocoa Research Scheme for the West Indies—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (October 1).

PROFESSORSHIP OF SOCIOLOGY at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 14).

LECTURERS (3) IN PHYSICS in the University of Queensland—The Agent-General for Queensland, 409 Strand, London, W.C.2, or The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Brisbane, October 18).

ALAN JOHNSTON, LAWRENCE and MOSELEY RESEARCH FELLOWSHIP into the problems of human and animal health and diseases and the biological field related thereto—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (November 1).

FOULERTON RESEARCH FELLOWSHIP IN MEDICINE—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (November 1).

DEMONSTRATOR IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, University College, Nottingham.

SENIOR LABORATORY TECHNICIAN (with extensive experience in pathology, bacteriology and haematology)—The Dean, Ophthalmic Institute, Moorfields Eye Hospital, City Road, London, E.C.1.

LECTURER IN PHYSICS—The Acting Principal, Royal Technical College, Peel Park, Salford 5.

LECTURER IN GEOLOGY AND BIOLOGY, a LECTURER IN PHYSICS AND CHEMISTRY, and LECTURERS (2) IN MATHEMATICS—The Principal, Derby Technical College, Normanton Road, Derby.

ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY (Insecticides and Fungicides)—The Registrar, The University, Reading.

ASSISTANT LECTURER IN THE DEPARTMENT OF ENGINEERING—The Registrar, University College, Singleton Park, Swansea.

MEDICAL BIOCHEMIST (male or female)—The General Superintendent and Secretary, Salford Royal Hospital, Salford.

SCIENTIFIC ASSISTANT—The Director, Imperial Bureau of Dairy Science, Shinfield, Reading, Berks.

LECTURER (*a*) IN PHYSICS, and (*b*) IN BIOLOGY, at the Queen Alya Institute—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

SENIOR PHYSICS TECHNICIAN at the biological research unit being established at the Atomic Energy Research Establishment, Harwell—The Medical Director, Medical Research Council Unit, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

ASSISTANT MASTERS (*a*) IN GENERAL SCIENCE AND CHEMISTRY, and (*b*) IN HISTORY AND GEOGRAPHY, at the King Faisal College—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

RESEARCH ASSISTANTS (2) to investigate insect and nematode pests of sugar beet—The Secretary, School of Agriculture, Cambridge.

PROFESSOR OF PSYCHOLOGY, a PROFESSOR OF EDUCATION, a PROFESSOR OF MATHEMATICS, a PROFESSOR OF CHEMISTRY, a PROFESSOR OF SOCIAL SCIENCES, a PROFESSOR OF PHYSICS, a PROFESSOR OF ENGLISH LANGUAGE AND LITERATURE, and a LECTURER in PHYSICS, at the Higher Teachers' Training College, Baghdad—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

SECRETARY TO THE UNIVERSITY—The Secretary, The University, Edinburgh.

PROFESSOR OF PHYSICS, a PROFESSOR OF MECHANICAL ENGINEERING, a PROFESSOR OF ELECTRICAL ENGINEERING, a PROFESSOR OF CIVIL ENGINEERING, a LECTURER IN PHYSICS, a LECTURER IN MECHANICAL ENGINEERING, a LECTURER IN MATHEMATICS (Descriptive Geometry), a LECTURER IN CIVIL ENGINEERING, a LECTURER IN ELECTRICAL ENGINEERING, and a LECTURER IN ARCHITECTURE, at the Engineering College, Baghdad—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

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Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 62, Part 3, No. 30: The Lorisoid Genus *Arctocebus*—Observations based on the Type Material. By Dr. W. C. Osman Hill. Pp. 245–265 + 1 plate. 3*s.* 6*d.* Vol. 62, Part 3, No. 31: The Identity of *Galago murinus* Murray. By Dr. W. C. Osman Hill. Pp. 266–270 + 1 plate. 1*s.* 6*d.* (Edinburgh and London: Oliver and Boyd, 1947.) [103

Scottish Marine Biological Association. Annual Report, 1945–46. Pp. 24. (Glasgow: Scottish Marine Biological Association, 1947.) [103

Dominions Office. Report on Nutrition in Newfoundland. By Dr. D. P. Cuthbertson. (Dominions No. 4.) Pp. 87. (London: H.M. Stationery Office, 1947.) 1*s.* 6*d.* net. [103

Farm Mechanization Enquiry. Farm Case Study No. 3: A Study of a 200 Acre Farm on Warp Land south of the Yorkshire Ouse in relation to its Use of Machinery. By John W. Y. Higgs, from the Field Work of Miss M. M. Sandilands. (Published for the National Institute of Agricultural Engineering.) Pp. 20. (London: H.M. Stationery Office, 1946.) 1*s.* net. [123

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Annals of the New York Academy of Sciences, Vol. 47, Art. 4: The Physico-Chemical Mechanism of Nerve Activity. By David Nachmansohn, Charles M. Berry, Oscar Bodansky, Frank Brink, Jr., Detlev W. Bronk, M. Vertner Brown, C. W. Coates, R. T. Cox, J. C. Eccles, Alfred Fessard, J. F. Fulton, R. W. Gerard, Alfred Gilman, D. E. Green, Joseph C. Hinsey, Rudolf Höber, Martin G. Larrabee and Tracy J. Putnam. Pp. 375–602. (New York: New York Academy of Sciences, 1946.) 3 dollars. [63

Travaux de l'Observatoire Géophysique à Swider. Nr. 10: Résultats des observations magnétiques à Swider (Pologne). Par Stanislaw Kalinowski. Pp. iv + 61. (Swider: Observatoire Géophysique, 1946.) [103

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Invertase: a Monograph. By Prof. Carl Neuberg and Dr. Irene S. Roberts. (Scientific Report Series, No. 4.) Pp. ix + 62. (New York: Sugar Research Foundation, Inc., 1946.) [103